Table of contents

Instructions: W0010042

Product: EV starting motor
Part no.: 0 001 23. ..

Continue: A01

Table of contents

Continue: V09/1

SPECIAL FEATURES

These instructions describe repair procedures for the following preengaged-drive starting motors of type EV

- 12 V/3.0 kW 0 001 230 ...
- 24 V/4.0 kW 0 001 231 ...

Continue: I02/2

SPECIAL FEATURES

Use is always to be made of a new parts set on assembly.

The water drain sockets are also to be renewed.

Lubricate in line with lubrication schedule before and during assembly.

Prior to assembly, use three-square scraper to remove all residual lacquer on fitting and sealing surfaces.

Continue: I03/1

SPECIAL FEATURES

After assembly, the starting motor must be sealed with nitrocellulose combination lacquer (5 899 607 017).

On starting motors with O-ring seals, Loctite 577 (5 994 090 000) must be applied to the relay bolts on fitting.

Continue: I03/2

SPECIAL FEATURES

The overrunning-clutch drive is subject to a high level of wear and is always to be replaced.

The bushings in the drive-end bearing and commutator end shield are always to be renewed.

The entire planetary gear train is to be replaced in the event of damage to or impermissible wear on the drive shaft of the planetary gear train.

Continue: I04/1

SPECIAL FEATURES

Starting motors of this type may differ in terms of the brush holder and commutator end shield.
Differences are found in the geometrical shape of the bracket for the excitation winding connection, in the connection at term. 45 in the area of the rubber seal and in the shape of this (old version trapezoidal, new version V-shaped).
The two versions are not compatible.
Exclusive use is to be made of parts as stipulated by the valid service parts list for the type of starting motor concerned.

Continue: I04/2

SPECIAL FEATURES

There is no form of solenoid switch testing which can provide reliable information on trouble-free operation over a long period.
It is therefore also advisable to renew the solenoid switch when repairing the starting motor.

Continue: I05/1

SPECIAL FEATURES

Starting motors may be equipped with a control relay.

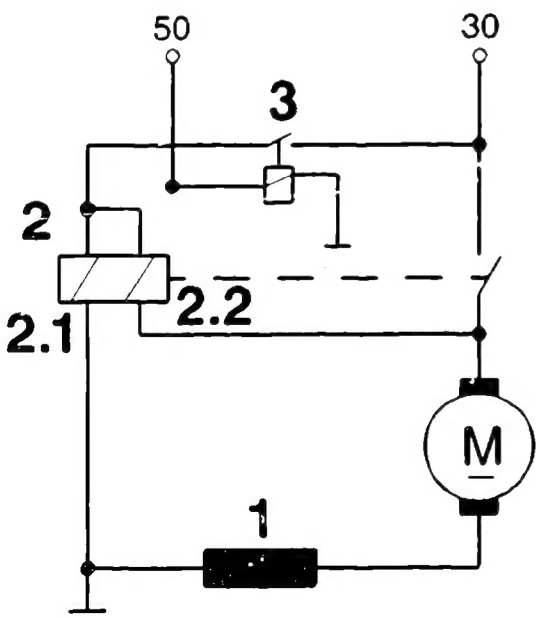
The control relay permits actuation of the solenoid switch of the starting motor for example by way of an engine control unit.

(12 V: Imax = 4 A)
(24 V: Imax = 2 A)

1 = Excitation winding
2 = Solenoid switch
2.1 = Holding winding
2.2 = Pull-in winding
3 = Control relay

Continue: I01/1 Fig.: I05/2

KMS00292



PC user prompting:
Position cursor on button and confirm.
Microcard user prompting:
User prompting is provided on every page e.g.:
- Continue: I 17/1
- Continue: II 18/1 Fig.: II 17/2

Brief instructions may include several rows of coordinates.
I../. = first coordinate row
II../. = second coordinate row
III../. = third coordinate row
etc.

.../1 = upper coordinate half
.../2 = lower coordinate half

Continue: I01/1

GENERAL

Unless otherwise stated, the voltages indicated in these instructions are DC voltages.
AC voltages are marked by the symbol " * ".

Continue: I07/2

GENERAL

Expert repairs are only possible using the prescribed tools and measuring instruments, which are in perfect working order. We therefore recommend that exclusive use be made of the tools listed.

The use of incorrect and unsuitable tools and testers can lead to injury and may damage the product concerned or its component parts.

Continue: I08/1

GENERAL

Some of the tools listed in these repair instructions were originally developed for a different application.

The appropriate instructions are to be heeded when using these tools.

Continue: I08/2

GENERAL

Only use replacement parts given in the service parts list for the starting motor concerned.

Proper functioning presupposes use of the lubricants specified in these instructions, both prior to and during assembly.

Absolute cleanliness is to be ensured when performing repair work.

Continue: I01/1

SAFETY MEASURES

Component cleaning:
Armature, excitation windings, commutator end shield, relay and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other components such as planetary gear train and drive-end bearing can be washed out in a commercially available cleaning agent which is not readily flammable. Take care never to inhale vapors. Components must be re-lubricated or re-greased in line with the lubrication schedule.

Continue: I09/2

SAFETY MEASURES

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Always use the listed tools. Injuries cannot be precluded if use is made of incorrect and unsuitable tools and testers.

Continue: I10/1

SAFETY MEASURES

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: I10/2

SAFETY MEASURES

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTERS, EQUIPMENT, TOOLS

All tools required for repairing starting motors of type EV are listed in the following.

Some of the tools needed have to be improvised in line with the drawings.

The type designation is given in parentheses for tools which used to be ordered on this basis.

Continue: I11/2

TESTERS, FIXTURES, TOOLS

Interturn short-circuit tester with test probes:	0 986 619 110
Test prods:	0 986 619 101
(Old version:	0 986 619 114)
Alternator tester WPG 012.00:	0 684 201 200
(alternatively, Motortester)	
Magnetic measurement stand:	4 851 601 124
Dial indicator:	1 687 233 011
Mandrel press:	comm. avail.

Continue: I12/1

TESTERS, FIXTURES, TOOLS

Clamping support:	0 986 619 362 (KDAW 9999)
Torque wrench (0...70 Nm):	comm. avail.
Torquemeter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
Spring balance (2...12 N):	0 986 619 181 (KDAW 9991)

Continue: I12/2

TESTERS, FIXTURES, TOOLS

Torx T30 bit socket with 1/4" hexagon:	comm. avail.
Torx T25 bit socket with 1/4" hexagon:	comm. avail.
Mounting sleeve/ stop ring:	0 986 617 114 (KDAL 5029)
Holder:	0 986 617 215 (KDAL 5487)

Continue: I13/1

TESTERS, FIXTURES, TOOLS

Circlip pliers:	comm. avail.
Flat-nose pliers:	comm. avail.
Gripping pliers:	comm. avail.
Hacksaw:	comm. avail.
Tailstock steady with Morse taper 2 for clamping diameter 5...45 mm for holding purposes when turning down armature:	0 986 619 156 (KDAW 9987)

Continue: I13/2

TESTERS, FIXTURES, TOOLS

Flat file:	comm. avail.
Vernier caliper:	comm. avail.
Three-square scraper:	comm. avail.
Column drill:	comm. avail.
Machine vice:	comm. avail.
HSS drill bit 4,3 mm:	comm. avail.

Continue: I14/1

TESTERS, FIXTURES, TOOLS

Bushing extractor:	0 986 617 243 (KDAL 5493)
Spring collet for bushings Diameter 12.5 mm:	0 986 617 246 (KDAL 5493/0/3)
Spring collet for bushings Diameter 10 mm:	0 986 617 250 (KDAL 5493/0/7)

Continue: I14/2

TESTERS, FIXTURES, TOOLS

Locating sleeve/ brush holder:	0 986 618 134 (KDLJ 6018)
Pressing-in mandrel:	0 986 617 149 (KDAL 5058)
Pressing-in mandrel with locating collar:	0 986 617 212 (KDAL 5486)

Continue: I15/1

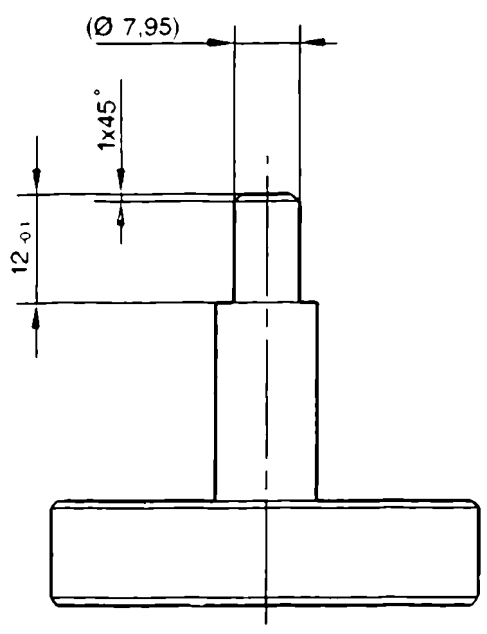
TESTERS, EQUIPMENT, TOOLS

Assembly stand for planetary gear train: 0 986 617 138 (KDAL 5047) (reworked version)

ATTENTION:
The 7.95 mm dia. pin at the assembly stand must be shortened to the dimension stated on the drawing.

Continue: I01/1 Fig.: I15/2

KMS00289



TEST SPECIFICATIONS AND SETTINGS

Commutator - minimum diameter:	31 mm
Eccentricity - Commutator:	< 0,01 mm
Armature axial clearance:	0,05...0,7 mm
Total pinion travel a:	17...19 mm
Armature braking torque:	1,1...2,1 Nm
Wear dimension x of carbon brushes:	< 18 mm

Continue: I16/2

TEST SPECIFICATIONS AND SETTINGS

Overrunning clutch torque:	0,35...0,65 Nm

Continue: I17/1

TEST SPECIFICATIONS AND SETTINGS

Solenoid switch energization voltage

12 V starting motor:	5...8 V
24 V starting motor:	15...18 V

Solenoid switch resistance values

Pull-in winding/ 12 V starting motor 0 001 230 ...:	0,2...0,25 Ohm
Pull-in winding/ 24 V starting motor 0 001 231 ... depending on version:	1,0...1,1 Ohm 1,2...1,4 Ohm

Continue: I17/2

TEST SPECIFICATIONS AND SETTINGS

Solenoid switch resistance values

Holding winding/ 12 V starting motor 0 001 230 ...:	1,0...1,1 Ohm
Holding winding/ 24 V starting motor 0 001 231 ... depending on version:	3,2...3,6 Ohm 4,1...4,6 Ohm

Continue: I01/1

TIGHTENING TORQUES

Attachment of commutator end shield and drive-end bearing:	8,9...11,1 Nm
Relay attachment:	4,5...6,0 Nm
Connection, brush holder, term. 45:	10...12 Nm
Connection, excitation winding, brush holder:	3,3...4,1 Nm
Connection term. 30:	16,0...20,0 Nm

Continue: I18/2

TIGHTENING TORQUES

Connection, term. 50 for attachment with	
- Bolt M4:	1,0...1,4 Nm
- Bolt M6:	2,4...3,0 Nm
- Pin M5:	2,0...2,5 Nm
- Pin M6:	3,7...4,6 Nm

Continue: I01/1

LUBRICANTS/LUBRICATION SCHEDULE

General:

Commutator and carbon brushes are to be kept free of grease and oil.

Greased parts are to be degreased before re-lubricating them.

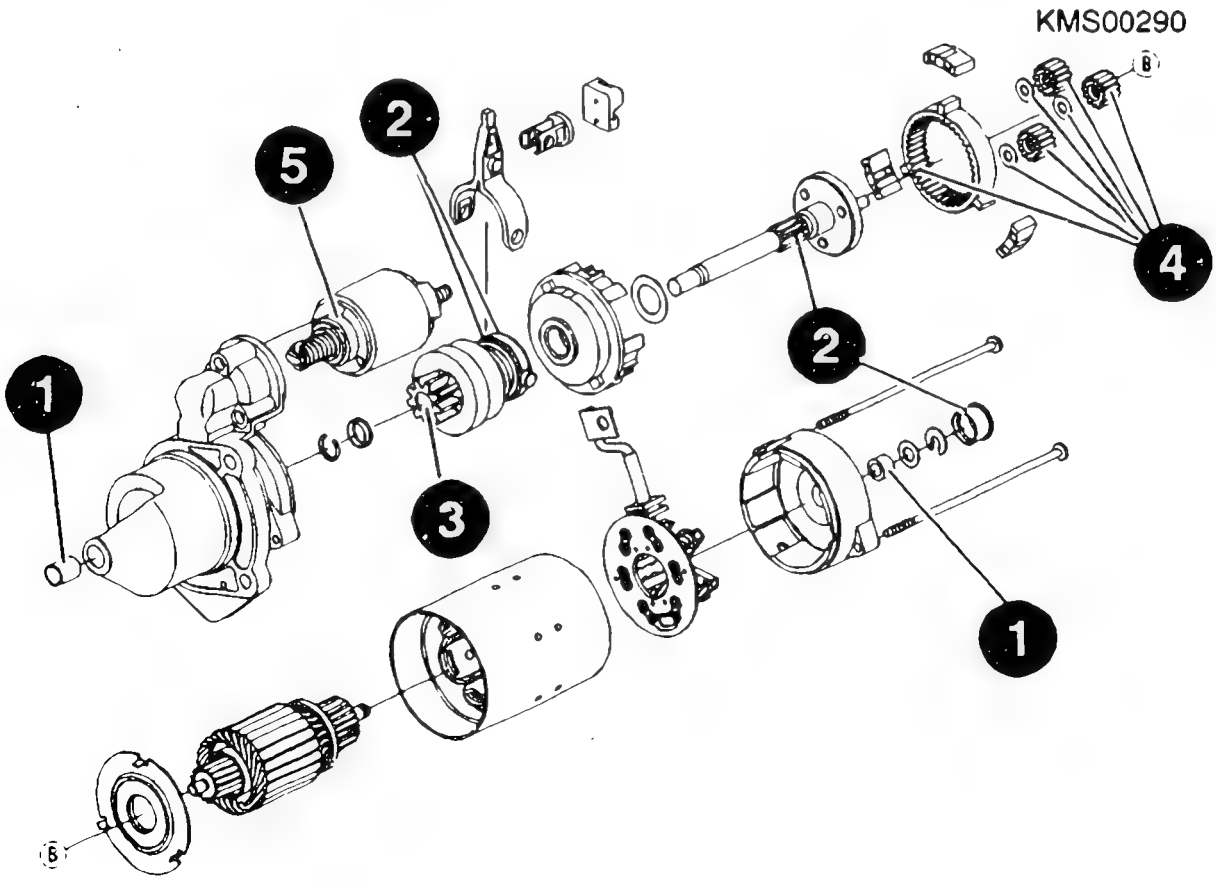
New bushings must be moistened prior to installation using suitable oil.
Oil VS 13 834-01: 5 962 260 000

Continue: I20/1

LUBRICANTS/LUBRICATION SCHEDULE

1	=	Oil VS 13834-Öl	5 962 260 000
2	=	Grease VS 10832-Ft	5 932 240 000
3	=	Grease VS 17427-Ft	5 995 778 000
4	=	Grease VS 16069-Ft	5 984 610 120
5	=	Gleitmo 1580 V	5 996 328 000

Continue: I01/1 Fig.: I20/2

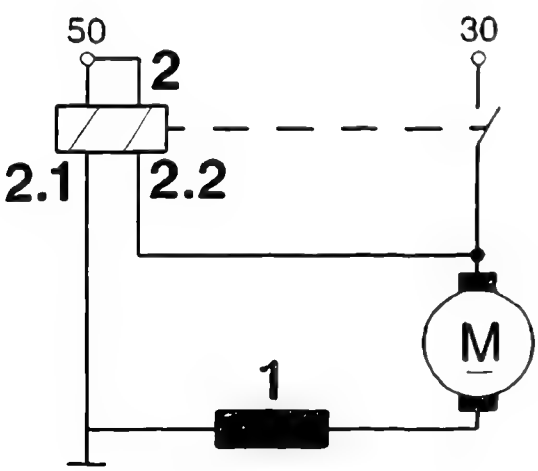


CIRCUIT DIAGRAM

1 = Excitation winding
2 = Solenoid switch
2.1 = Holding winding
2.2 = Pull-in winding

Continue: I01/1 Fig.: I21/2

KMS00291



STARTING MOTOR DISASSEMBLY TABLE

Continue: I01/1

STARTING-MOTOR DISASSEMBLY

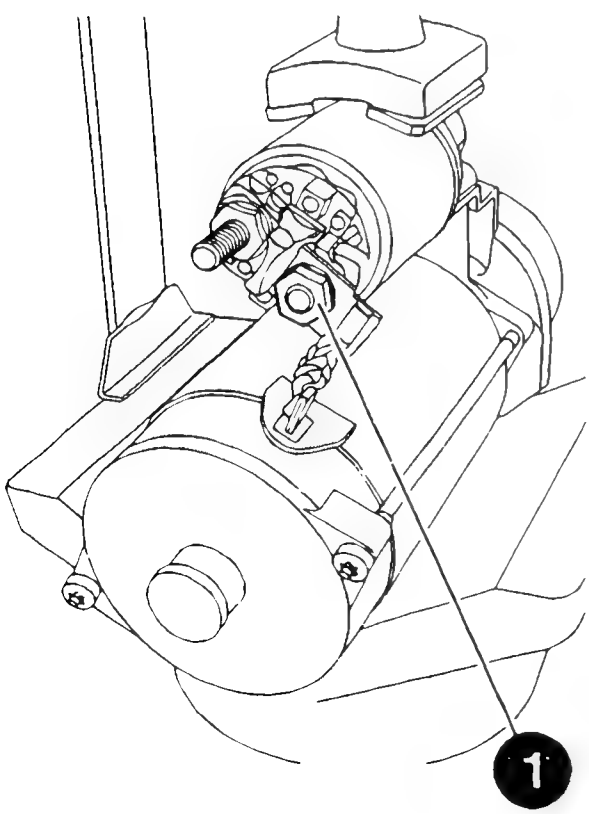
Solenoid-switch disassembly

Clamp starting motor in clamping support. Unfasten connection (1) of excitation winding at solenoid switch.

Clamping support: 0 986 619 362

Continue: I24/1 Fig.: I23/2

KMS00494



STARTING-MOTOR DISASSEMBLY

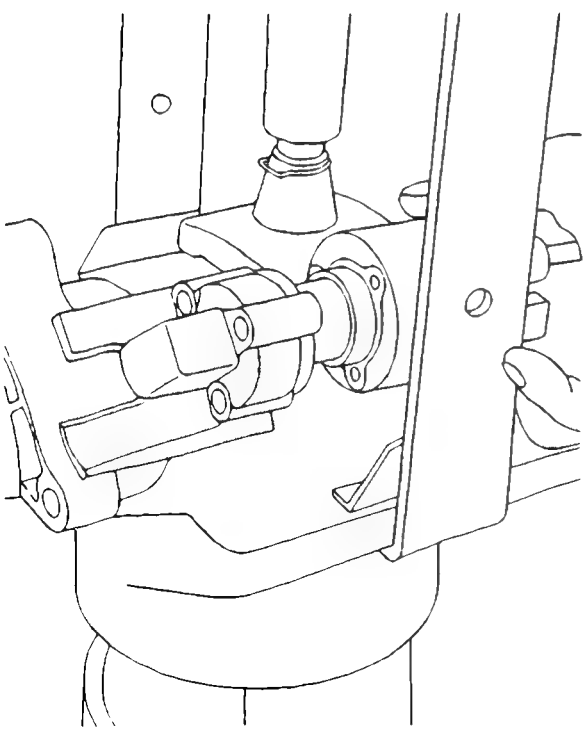
Solenoid-switch disassembly

Mark position of solenoid switch.
Unfasten relay screws.
ATTENTION: DANGER OF INJURY
The pretensioned return spring causes the solenoid switch to be pressed down by the relay armature.
Pull relay off relay armature.

Torx T25 bit: comm. avail.

Continue: I25/1 Fig.: I24/2

KMS00349



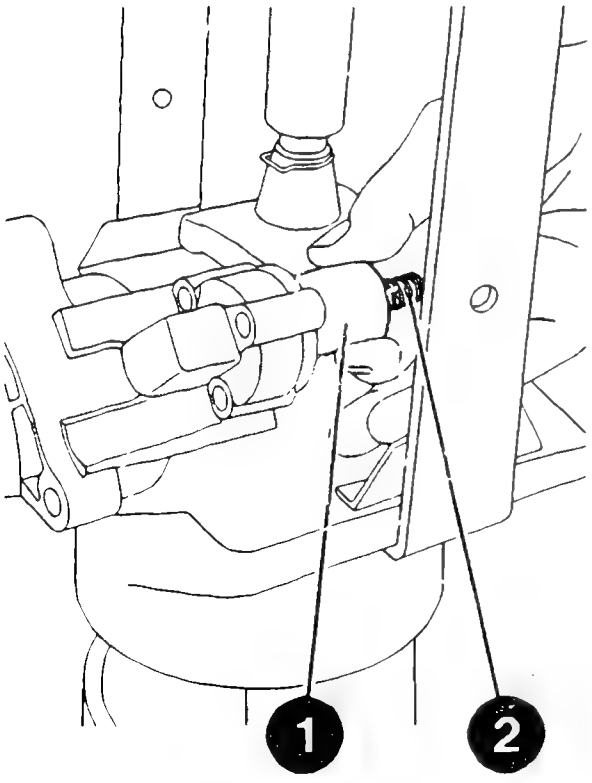
STARTING MOTOR DISASSEMBLY

Disassembling solenoid switch

Disengage relay armature (1) at fork lever.
Pay attention to return spring (2) in relay armature.

Continue: I22/1 Fig.: I25/2

KMS00350



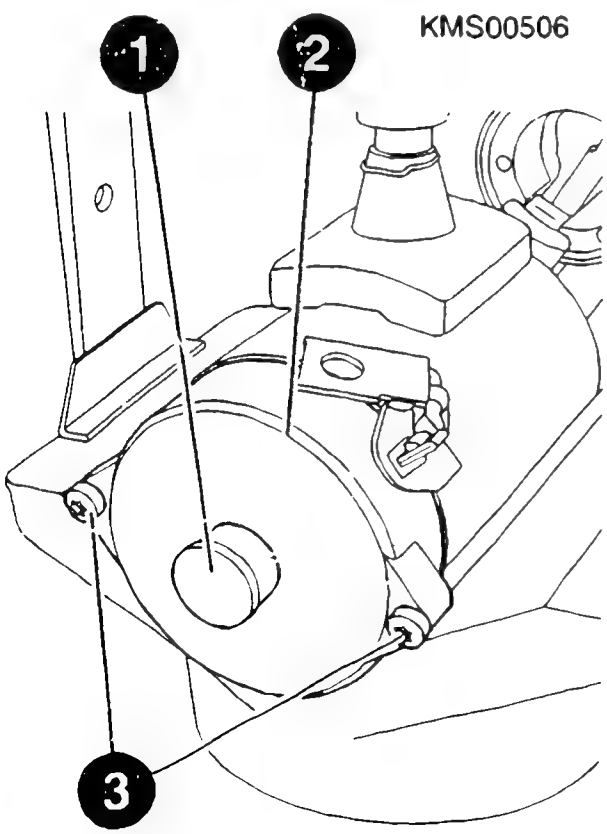
STARTING MOTOR DISASSEMBLY

Disassembling drive-end bearing

Prise off cap (1) at commutator end shield.
Mark installation position of drive-end bearing and commutator end shield (2) with respect to stator frame.
Slacken off bolts (3).

Torx T30 bit socket: comm. avail.

Continue: I27/1 Fig.: I26/2



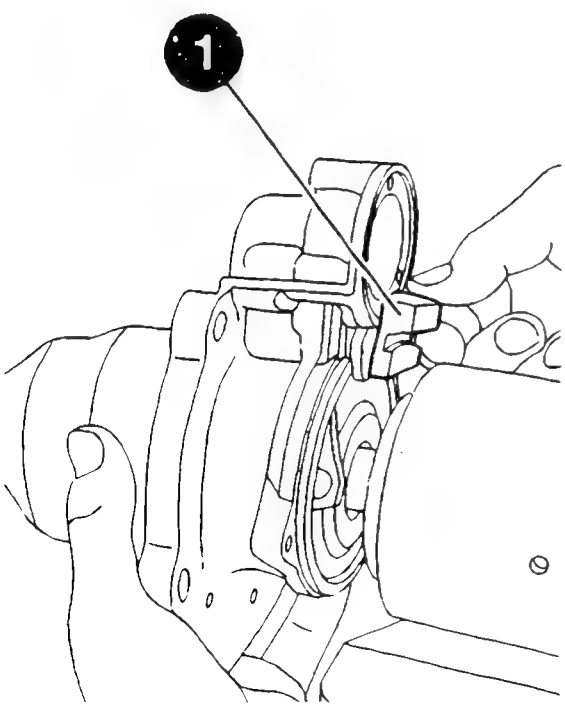
STARTING MOTOR DISASSEMBLY

Disassembling drive-end bearing

Detach drive-end bearing from stator frame; in doing so remove rubber seal (1) at bearing pedestal of fork lever.

Continue: I22/1 Fig.: I27/2

KMS00297



STARTING MOTOR DISASSEMBLY

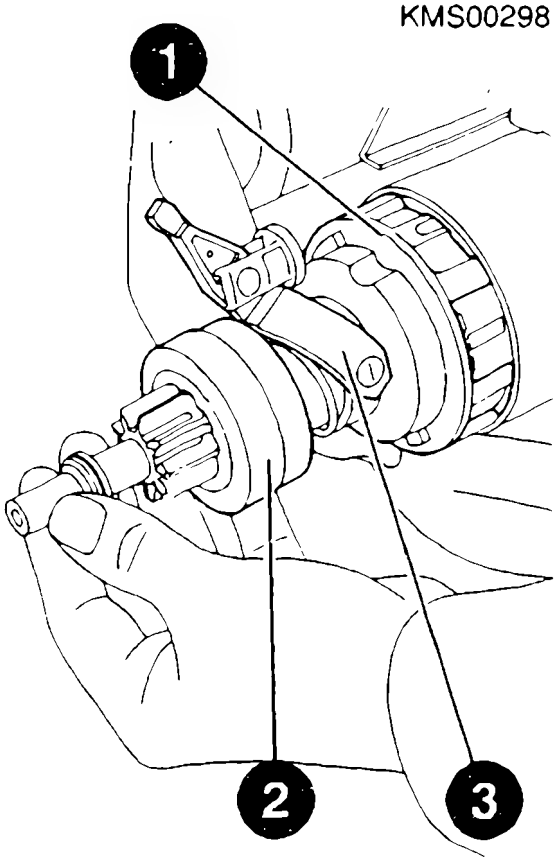
Disassembling overrunning-clutch drive and planetary gear train

Pull planetary gear train (1) with overrunning-clutch drive (2) and fork lever (3) out of stator frame.
NOTE: Planetary gear train may stick in stator frame if lacquer has ingressed.
Slip assembly horizontally onto stand and position vertically so as to avoid damage.

Assembly stand for planetary gear train (reworked): 0 986 617 138

Continue: I22/1 Fig.: I28/2

KMS00298



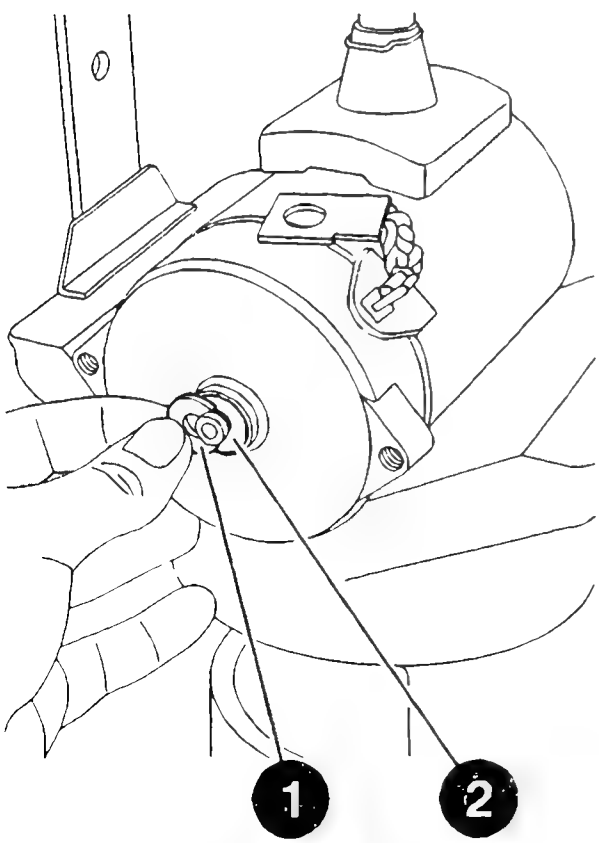
STARTING MOTOR DISASSEMBLY

Disassembling commutator end shield

Detach retaining collar (1) of armature shaft and shim (2).
NOTE: In the event of burr at the armature shaft groove, this is to be removed first, using for example a whetstone.

Continue: II02/1 Fig.: II01/2

KMS00505



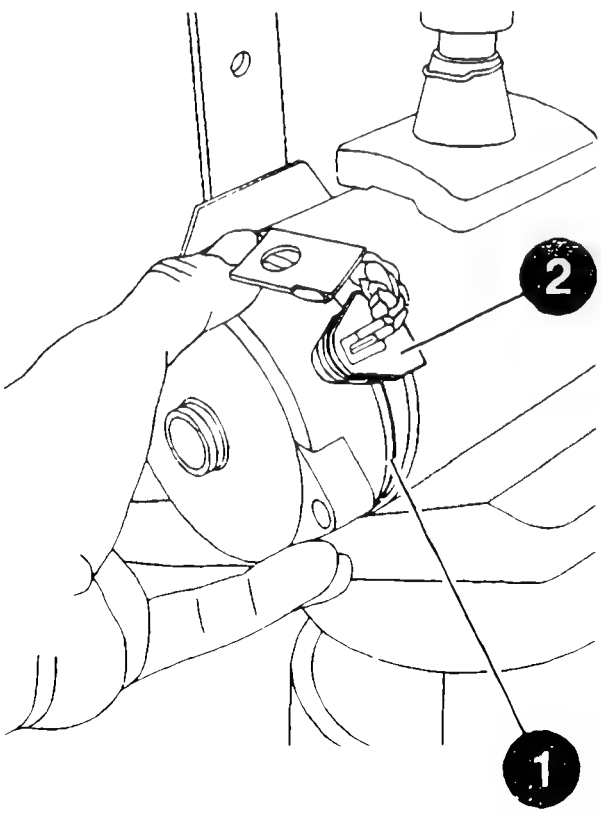
STARTING MOTOR DISASSEMBLY

Disassembling commutator end shield

Detach commutator end shield (1) from stator frame, taking care not to damage gasket (2).

Continue: I22/1 Fig.: II02/2

KMS00495



STARTING MOTOR DISASSEMBLY

Disassembling armature

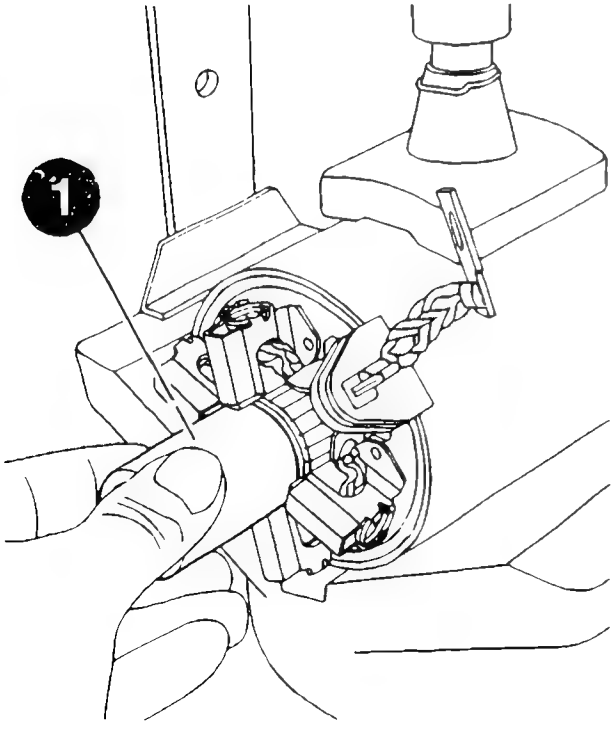
Attach locating sleeve (1) to armature shaft from commutator end.

ATTENTION: Make sure armature shaft is not damaged by thread in locating sleeve.

Locating sleeve: 0 986 618 134

Continue: II04/1 Fig.: II03/2

KMS00504



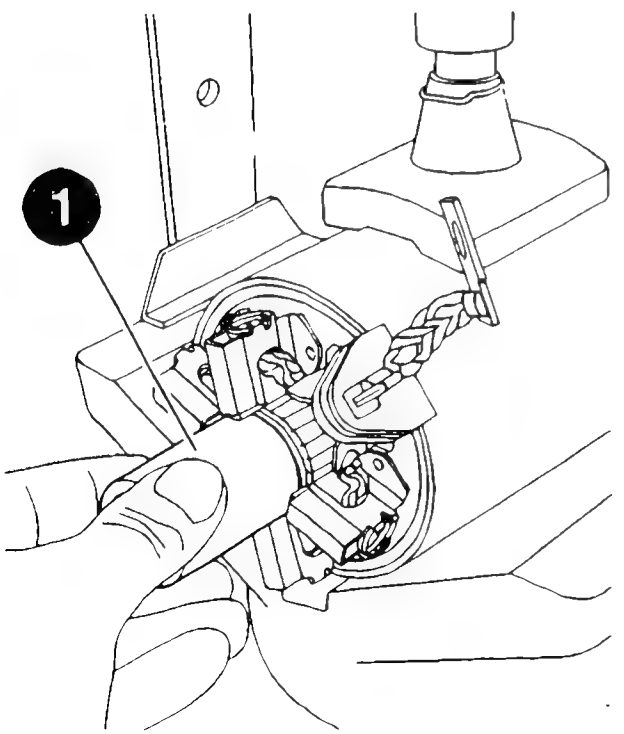
STARTING MOTOR DISASSEMBLY

Disassembling armature

Press armature out of stator frame to drive-end bearing side and in doing so insert locating sleeve (1) in brush holder.
The carbon brushes must rest on the tool.
ATTENTION: Take care not to damage excitation winding.

Continue: I22/1 Fig.: II04/2

KMS00504



STARTING MOTOR DISASSEMBLY

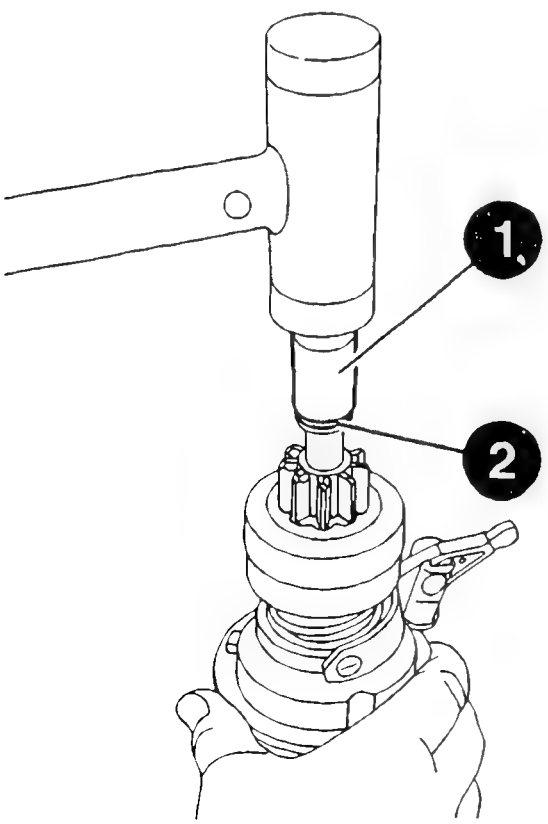
Disassembling overrunning-clutch drive

Attach disassembly sleeve (1) to drive shaft such that collar of sleeve is facing upwards.
Tap firmly (plastic-headed hammer) on assembly sleeve to knock back stop ring.

Disassembly sleeve/
stop ring: 0 986 617 114

Continue: II06/1 Fig.: II05/2

KMS00306



STARTING MOTOR DISASSEMBLY

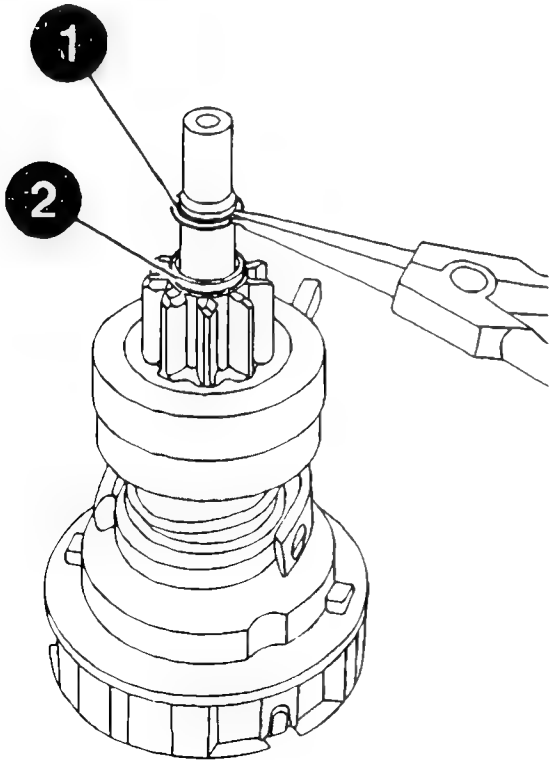
Disassembling overrunning-clutch drive

Bend open circlip (1) with pliers and detach from drive shaft.
Take care not to damage drive shaft when doing so.
Detach stop ring (2) from drive shaft.
NOTE: In the event of burr at the drive shaft groove, this is to be removed first using, for example, a whetstone.

Circlip pliers: comm. avail.

Continue: II07/1 Fig.: II06/2

KMS00307



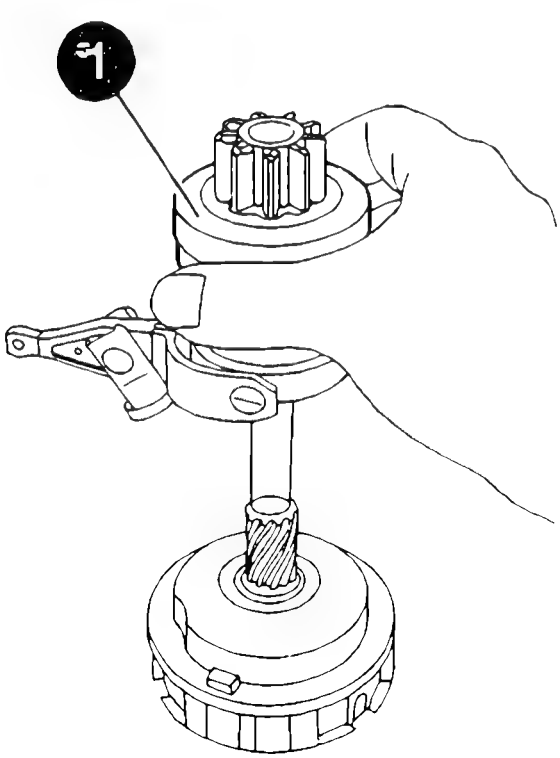
STARTING MOTOR DISASSEMBLY

Disassembling overrunning-clutch drive

Pull overrunning-clutch drive (1) with fork lever off drive shaft.

Continue: I22/1 Fig.: II07/2

KMS00308



COMPONENT CLEANING

Component cleaning:
Armature, excitation windings, commutator end shield, relay and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other components such as planetary gear train and drive-end bearing can be washed out in a commercially available cleaning agent which is not readily flammable. Take care never to inhale vapors. Components must be re-lubricated or re-greased in line with the lubrication schedule.

Continue: II08/2

COMPONENT CLEANING

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Continue: II09/1

COMPONENT CLEANING

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: II09/2

COMPONENT CLEANING

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTING, REPAIR TABLE

Continue: II1 0/2

TESTING, REPAIR TABLE

Continue: I01/1

COMPONENT TESTING AND REPAIR

Testing pinion

Meshing pinion and overruning-clutch drive are subject to considerable wear. Overruning-clutch drive is therefore always to be replaced.

Continue: II10/1

COMPONENT TESTING AND REPAIR

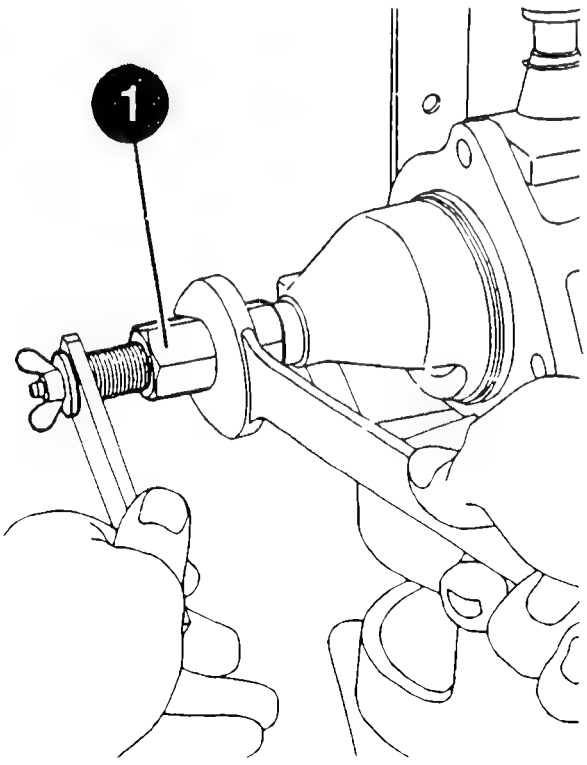
Testing drive-end bearing

Bushing of drive-end bearing is always to be replaced.
Removing: Clamp drive-end bearing in clamping support. Use puller (1) and spring collet to pull bushing out of drive-end bearing.

Clamping support:	0 986 619 362
Puller:	0 986 617 243
Spring collet diameter 12.5 mm:	0 986 617 246

Continue: II13/1 Fig.: II12/2

KMS00271



COMPONENT CHECKING AND REPAIR

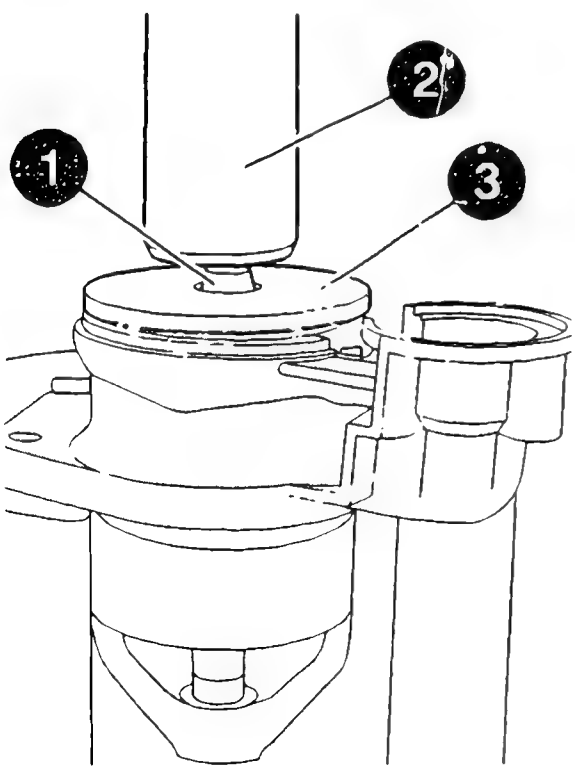
Checking drive-end bearing

Installation: Use pressing-in mandrel (1) to carefully press new bushing from inside into drive-end bearing until press mandrel (2) makes contact with locating collar (3).
Make sure locating collar (3) is correctly positioned in drive-end bearing flange.
ATTENTION: New bushing is to be moistened beforehand with suitable oil.

Mandrel press:	comm. avail.
Pressing-in mandrel:	0 986 617 212
Oil VS 13 834-01:	5 962 260 000

Continue: II14/1 Fig.: II13/2

KMS00309



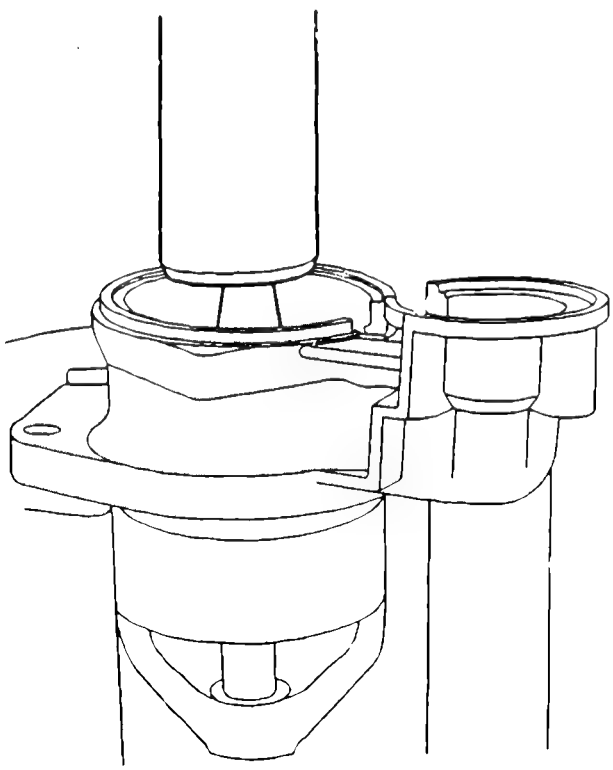
COMPONENT CHECKING AND REPAIR

Checking drive-end bearing

Further installation: Detach locating collar and carefully press home bushing in drive-end bearing.

Continue: II10/1 Fig.: II14/2

KMS00310



COMPONENT CHECKING AND REPAIR

Checking commutator end shield

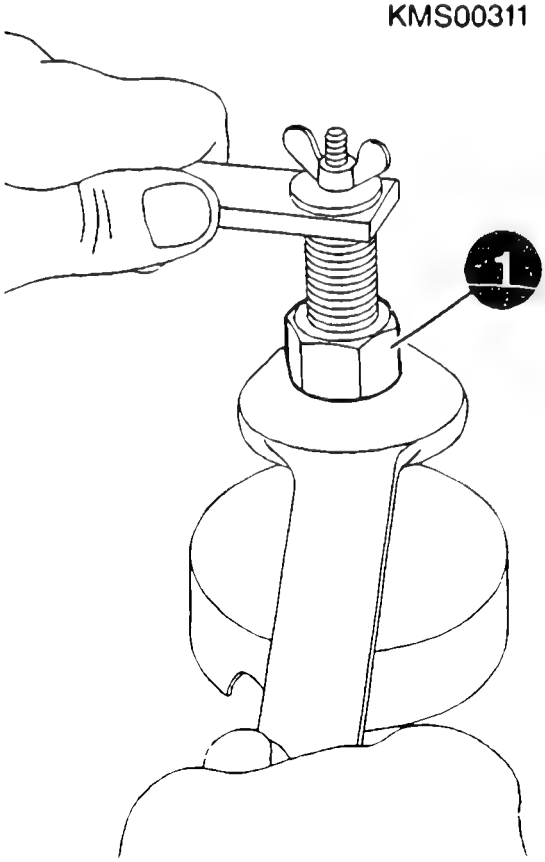
Bushing of commutator end shield is always to be replaced.

Removal: Use puller (1) and spring collet to pull bushing out of commutator end shield.

Puller:	0 986 617 243
10 mm dia. spring collet:	0 986 617 250

Continue: II16/1 Fig.: II15/2

KMS00311



COMPONENT CHECKING AND REPAIR

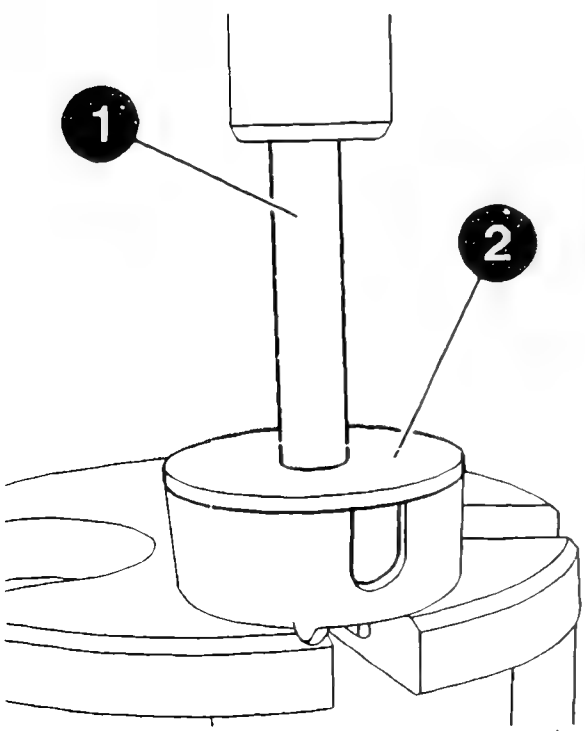
Checking commutator end shield

Installation: Press new bushing with pressing-in mandrel (1) and locating sleeve (2) into commutator end shield from inside.
Make sure locating sleeve (2) is properly positioned in commutator end shield.
ATTENTION: Moisten new bushing beforehand with suitable oil.

Mandrel press:	comm. avail.
Pressing-in mandrel:	0 986 617 149
Locating collar:	0 986 617 212
Oil VS 13 834-Öl:	5 962 260 000

Continue: II10/1 Fig.: II16/2

KMS00362



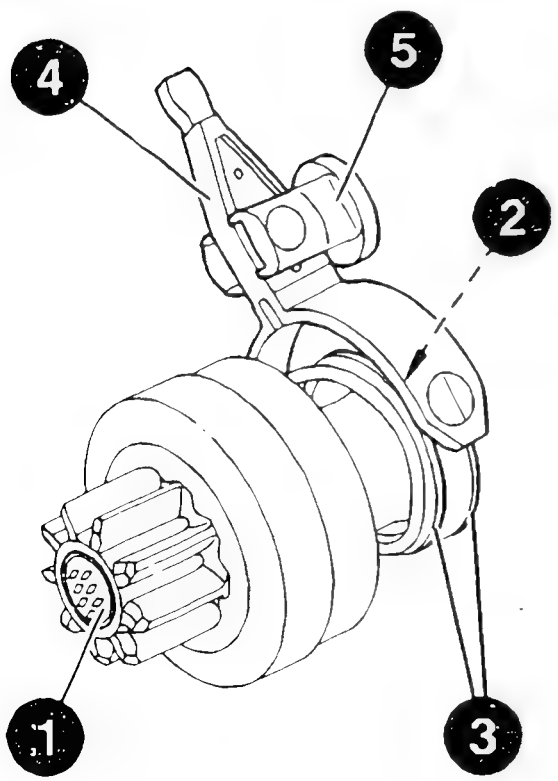
COMPONENT CHECKING AND REPAIR

Replacing overrunning-clutch drive

Pinion, bushings (1), spiral spline (2) and drive edges (3) of the overrunning-clutch drive are subject to a high level of wear.
The overrunning-clutch drive is therefore always to be replaced.
Also replace fork lever (4) and bearing pedestal (5) of fork lever.

Continue: II18/1 Fig.: II17/2

KMS00313



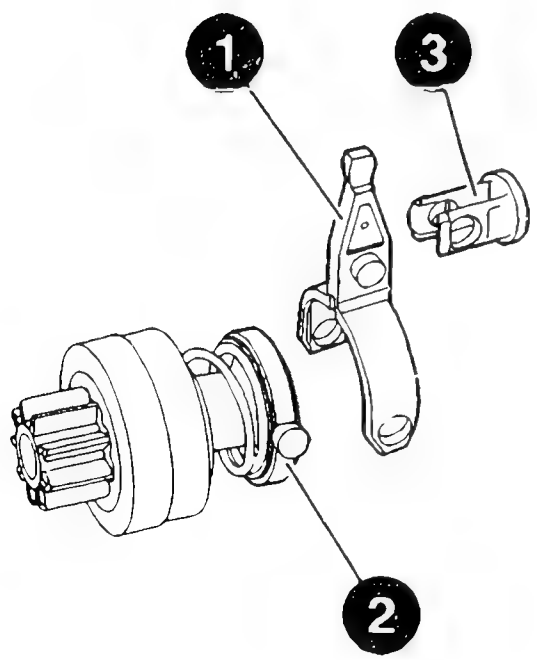
COMPONENT CHECKING AND REPAIR

Replacing overrunning-clutch drive

Engage new fork lever (1) at driver (2) at overrunning-clutch drive.
Engage new bearing pedestal (3) at fork lever with open side facing pinion.
NOTE: Fig. shows disassembled fork lever and bearing pedestal.

Continue: II10/1 Fig.: II18/2

KMS00314



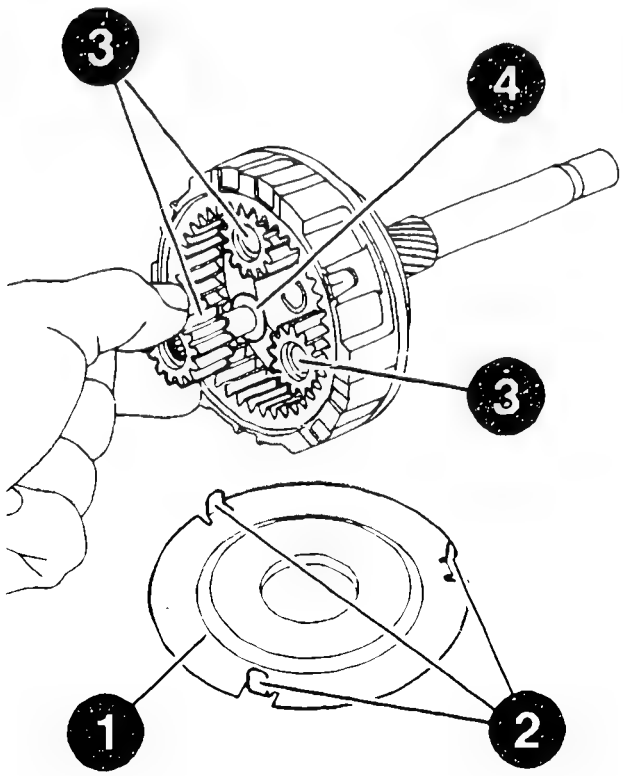
COMPONENT CHECKING AND REPAIR

Checking planetary gear train

Disassembling:
Detach assembly from stand.
Detach cover (1).
NOTE: Even if the retaining lugs (2) have broken off, the cover is still functional and can be re-used.
Remove planet gears (3). Pay attention to the positioners (4) under the planet gears.

Continue: II20/1 Fig.: II19/2

KMS00315



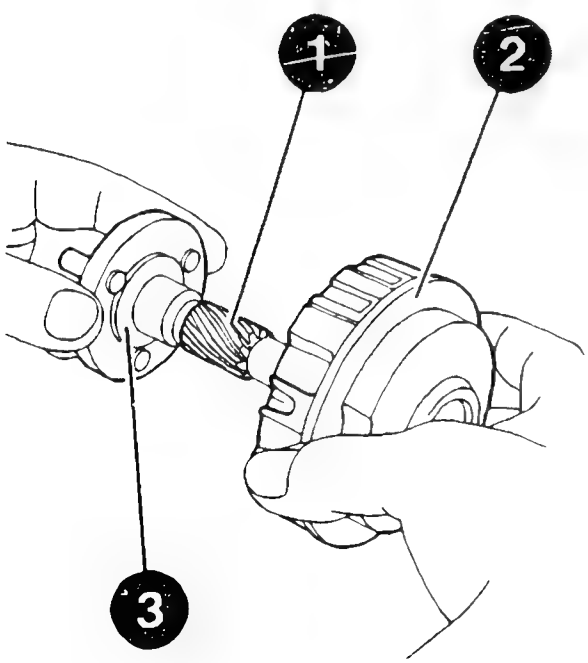
COMPONENT CHECKING AND REPAIR

Checking planetary gear train

Further disassembly:
Pull drive shaft (1) out of intermediate bearing (2). Pay attention to TX collar (3).

Continue: II21/1 Fig.: II20/2

KMS00316

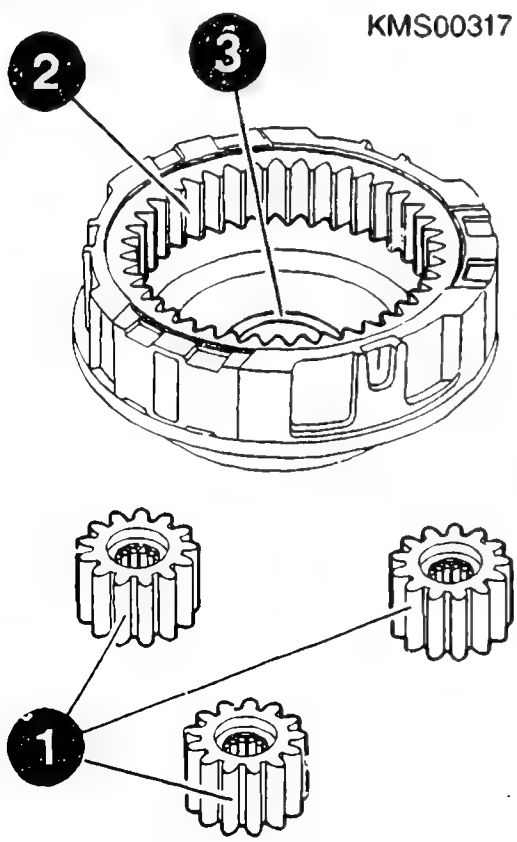


COMPONENT CHECKING AND REPAIR

Checking planetary gear train

In the event of worn planet gears (1), internal gear (2), bushing (3) or positioners beneath the planet gears, the entire planetary gear train is to be replaced.

Continue: II22/1 Fig.: II21/2



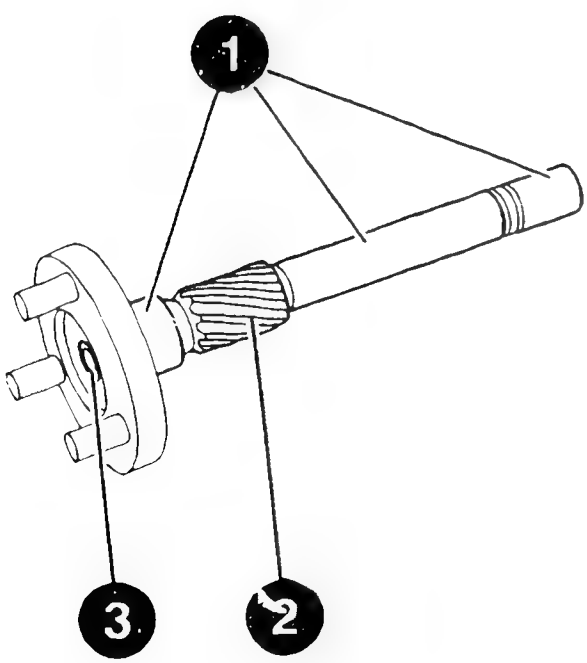
COMPONENT CHECKING AND REPAIR

Checking planetary gear train

If one of the bearing surfaces (1) on the drive shaft or the spiral spline (2) or the sun gear bushing (3) is worn or damaged, then the entire planetary gear train is also to be replaced.

Continue: II23/1 Fig.: II22/2

KMS00318



COMPONENT CHECKING AND REPAIR

Checking planetary gear train

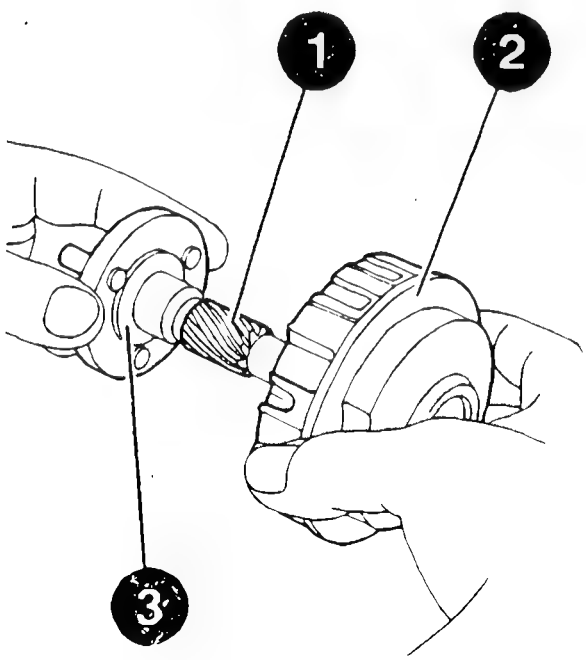
Assembly:
Prior to assembly, clean planetary gear train and remove both carbon brush abrasion and swarf.
Lubricate in line with lubrication schedule during assembly.

Slip TX collar (3) onto drive shaft (1).
Insert drive shaft in intermediate bearing (2).

Grease VS 16069-Ft: 5 984 610 120

Continue: II24/1 Fig.: II23/2

KMS00316



COMPONENT CHECKING AND REPAIR

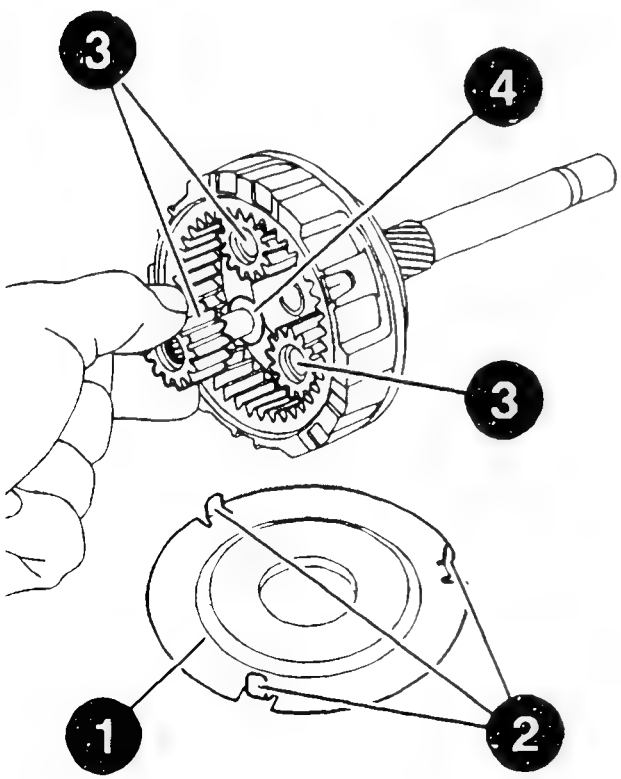
Checking planetary gear train

Further assembly:
Insert positioners (4) and planet gears (3) in intermediate bearing.
Fit cover (1), slip planetary gear train onto assembly stand and position vertically.
NOTE: Even if the retaining lugs (2) have broken off, the cover is still functional and can be re-used.

Assembly stand (reworked): 0 986 617 138

Continue: II10/1 Fig.: II24/2

KMS00315



COMPONENT TESTING AND REPAIR

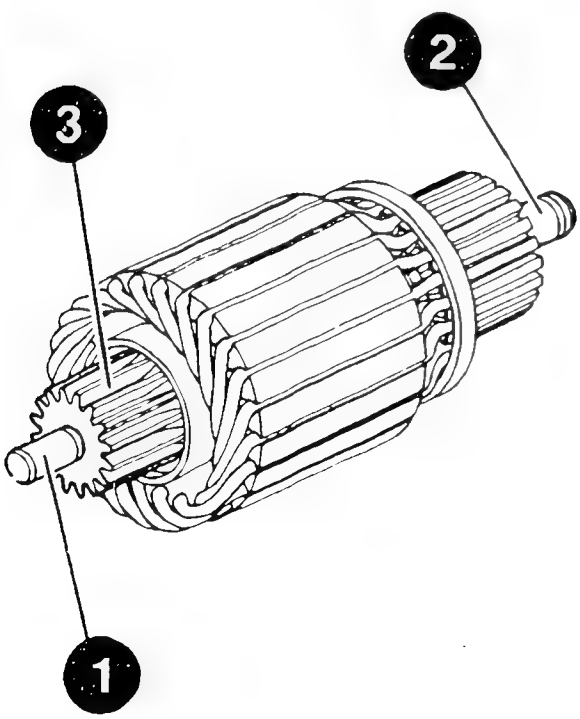
Checking armature

Examine bearing surface of sun gear bushing (1) and commutator end shield (2), as well as sun gear (3) for scoring and damage.

Replace armature if necessary.

Continue: II26/1 Fig.: II25/2

KMS00319



COMPONENT TESTING AND REPAIR

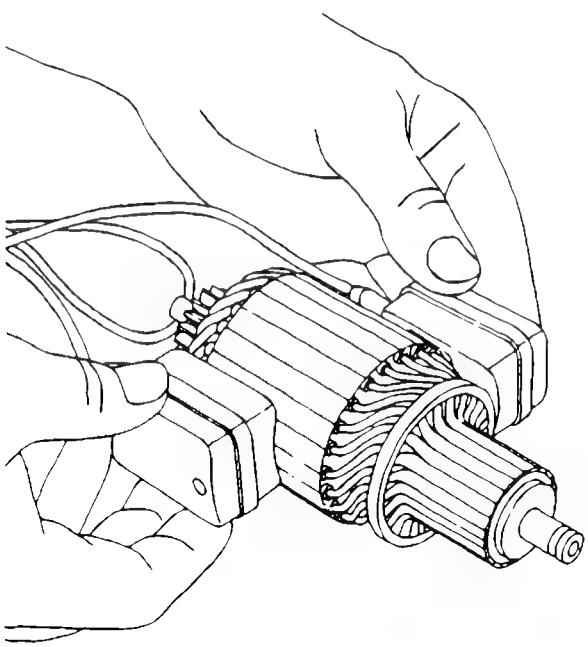
Testing armature

Check armature for interturn short circuit using tester and test probes.

Interturn short-circuit tester with test probes: 0 986 619 110

Continue: II27/1 Fig.: II26/2

KMS00320



Testing armature

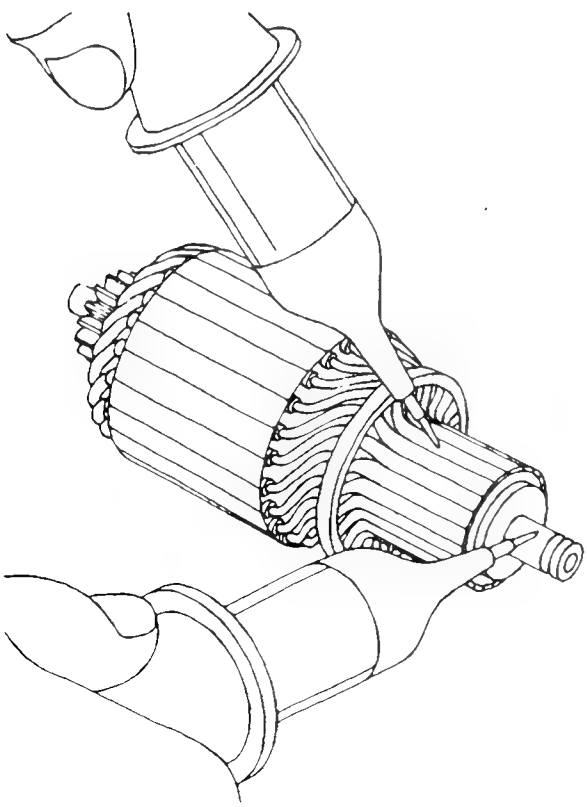
Use tester and test prods to check armature for short to ground and continuity (black laminations indicate open circuit).

Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101
Ground-short test voltage	
12 V starting motor:	40 V*
24 V starting motor:	80 V*
Continuity test voltage:	40 V*

* = AC voltage

Continue: II10/1 Fig.: II27/2

KMS00321



COMPONENT TESTING AND REPAIR

Testing commutator

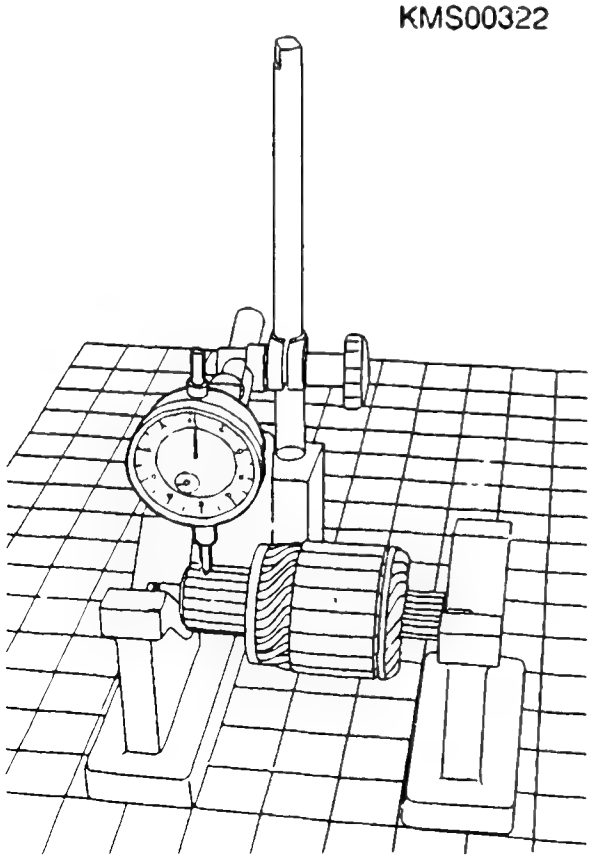
Check commutator concentricity.
If radial run-out is outside stated range, commutator must be turned down.

Magnetic measurement stand:	4 851 601 124
Dial indicator:	1 687 233 011

Radial run-out - Commutator:	< 0,01 mm

Continue: III01/1 Fig.: II28/2

KMS00322



COMPONENT TESTING AND REPAIR

Testing commutator

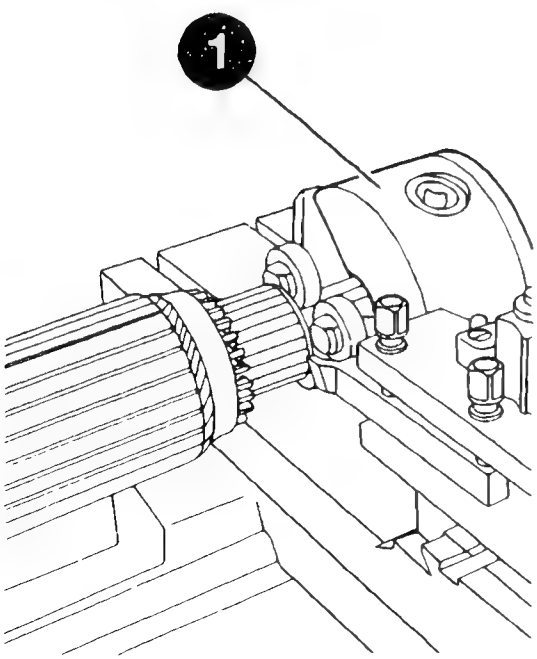
Turning down involves positioning armature in three-jaw chuck and tailstock rest (1). The max. machining thickness is 0.03 mm.
Pay attention to minimum diameter.

Tailstock rest with Morse taper 2: 0 986 619 156

Mininum diameter: 31 mm

Continue: III02/1 Fig.: III01/2

KMS00193



COMPONENT TESTING AND REPAIR

Checking commutator

After turning down, the commutator segment insulation must be sawn out to a depth of 0.8 mm with a suitable tool.

After sawing out, turn down commutator again and check armature for interturn short circuit and short to ground. Pay attention to diameter.

The carbon-brush wear dimension is also to be checked with turned-down armature.

Continue: III02/2

COMPONENT CHECKING AND REPAIR

Relace brush holder if necessary.

Interturn short-circuit tester:	0 986 619 110
Min. diameter:	31 mm
Wear dimension x of carbon brushes:	< 18 mm
Ground short test voltage	
12 V starting motor:	40 V*
24 V starting motor:	80 V*

* = AC

Continue: II10/1

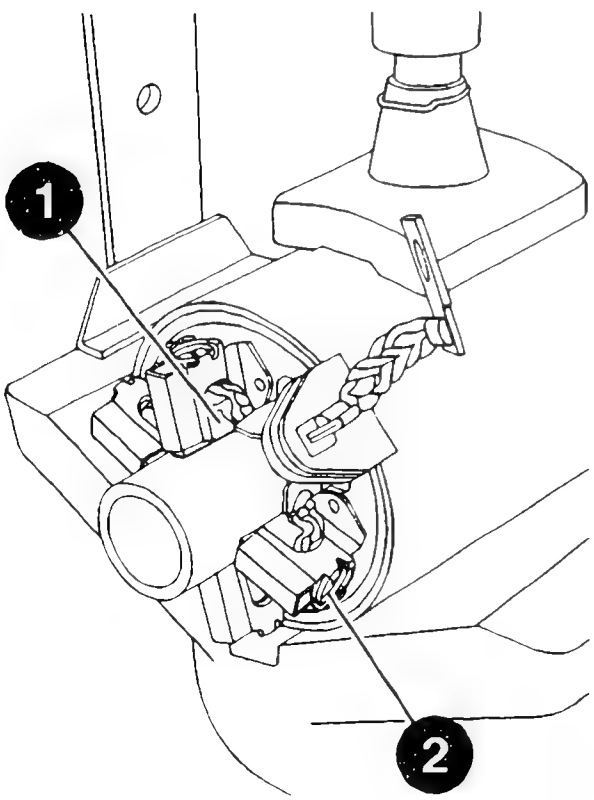
COMPONENT CHECKING AND REPAIR

Checking brush holder

If carbon brushes (1) are worn down to minimum length or damaged or if the helical compression springs (2) are worn, then the entire brush holder is to be replaced.
NOTE: The commutator end shield also has to be replaced in the case of old starting motor versions. Exclusive use is to be made of parts as per the service parts list applicable to the type of starting motor concerned.

Continue: III04/1 Fig.: III03/2

KMS00503



COMPONENT CHECKING AND REPAIR

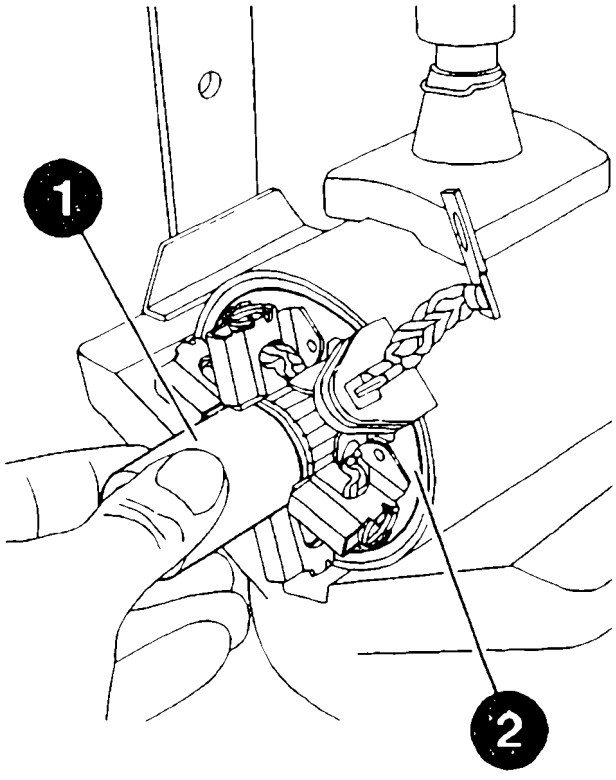
Checking brush holder

Check carbon brush wear.
ATTENTION: Wear dimension is to be checked with armature fitted.
Mount stator frame in clamping support.
Slide armature into stator frame from drive-end bearing side and at the same time pull locating sleeve (1) out of brush holder (2).
ATTENTION: Take care not to damage excitation winding.

Clamping support: 0 986 619 362

Continue: III05/1 Fig.: III04/2

KMS00502



COMPONENT CHECKING AND REPAIR

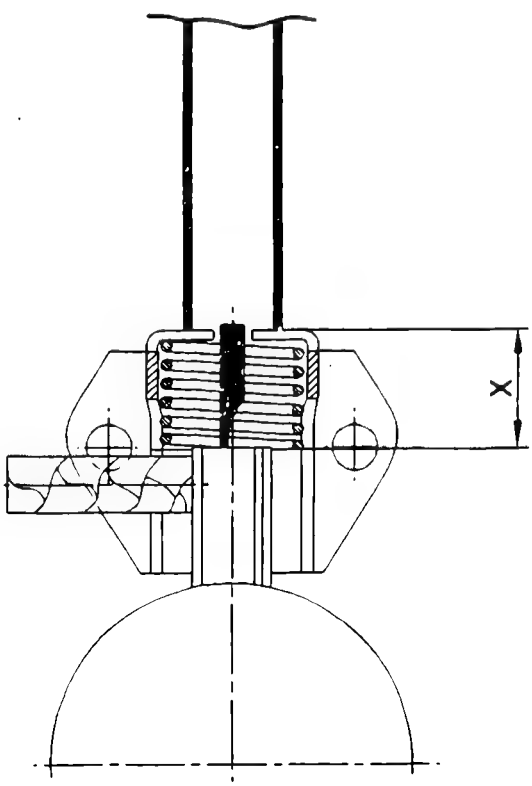
Checking brush holder

Use depth gauge to measure wear dimension x of carbon brushes from top edge of tubular brush holder to top edge of carbon brush.
After testing, slip locating sleeve back onto armature shaft, pull armature out of stator frame towards drive-end bearing side and in doing so insert locating sleeve in brush holder.

Wear dimension x
of carbon brushes: < 18 mm

Continue: II10/1 Fig.: III05/2

KMS00393



COMPONENT CHECKING AND REPAIR

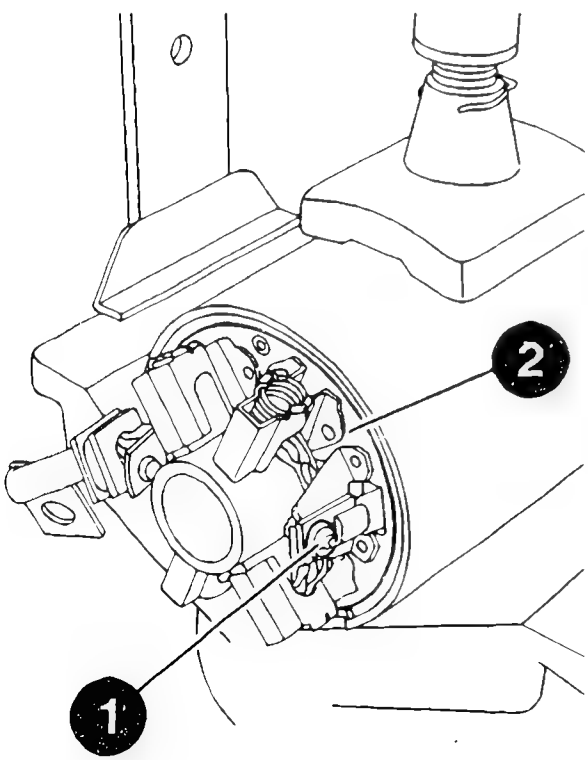
Replacing brush holder (bolted excitation winding connection)

NOTE: The commutator end shield is also to be replaced on replacing the brush holder.
Unfasten connection of excitation winding (1), detach brush holder (2). Use three-square scraper to remove residual lacquer from stator frame at brush holder seat.

Torx T25 bit socket:	comm. avail.
Three-square scraper:	comm. avail.

Continue: III07/1 Fig.: III06/2

KMS00326



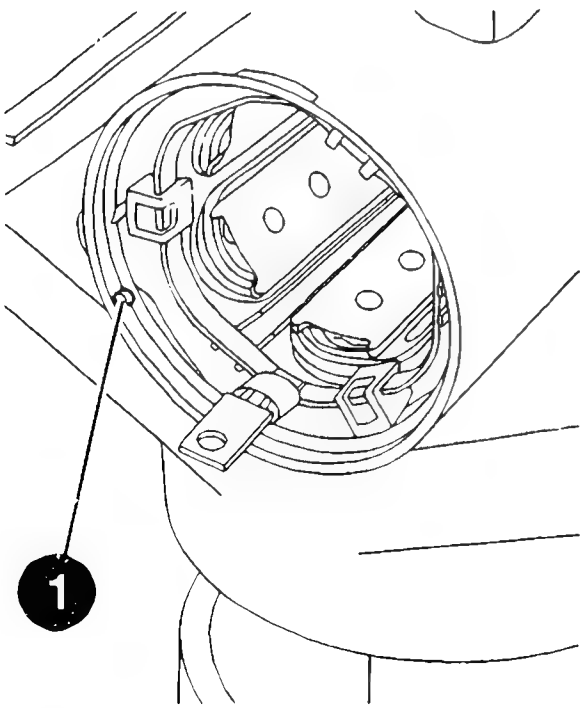
COMPONENT CHECKING AND REPAIR

Replacing brush holder (bolted excitation winding connection)

Mark position of locking lug (1) at end face of stator frame.

Continue: III08/1 Fig.: III07/2

KMS00508



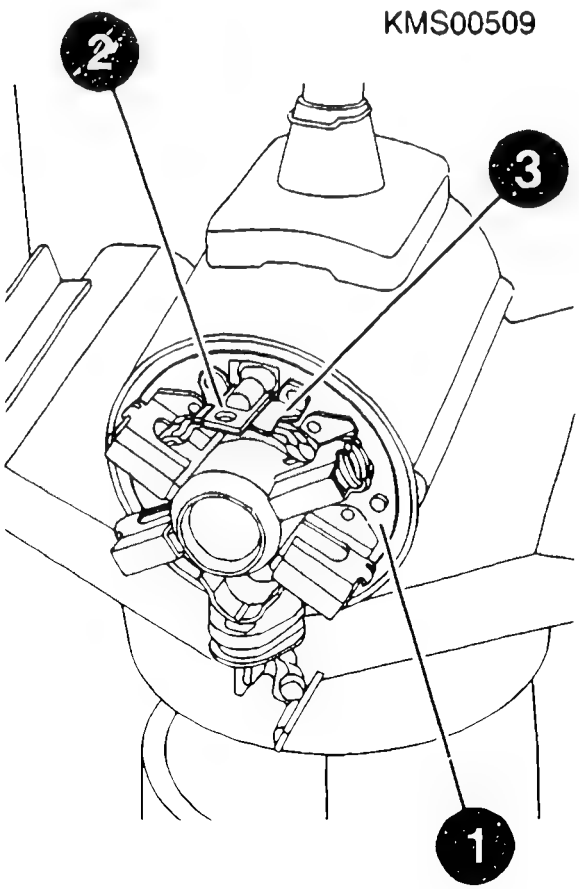
COMPONENT CHECKING AND REPAIR

Replacing brush holder (bolted excitation winding connection)

Insert new brush holder (1) in stator frame such that stranded connecting wire (2) rests centrally on bracket (3).
Transfer lug position mark from stator frame to brush holder.

Continue: III09/1 Fig.: III08/2

KMS00509



COMPONENT CHECKING AND REPAIR

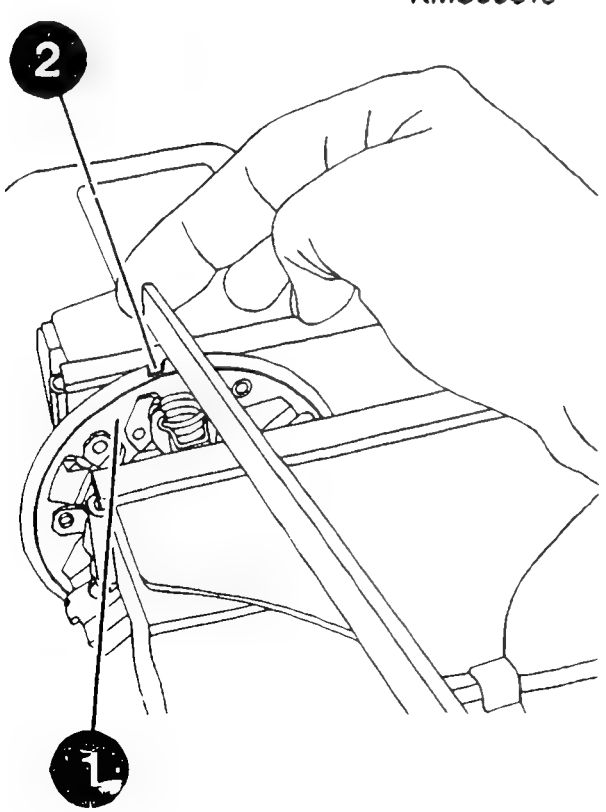
Replacing brush holder (bolted excitation winding connection)

Carefully clamp brush holder (1) in vice between soft jaws. Use flat file to make 3 mm wide and 1.5 mm deep recess (2) in brush holder.
ATTENTION: Take care not to damage brush holder, in particular insulation and tubular brush holders.
Then clean brush holder with compressed air.

Flat file: comm. avail.

Continue: III10/1 Fig.: III09/2

KMS00510



COMPONENT CHECKING AND REPAIR

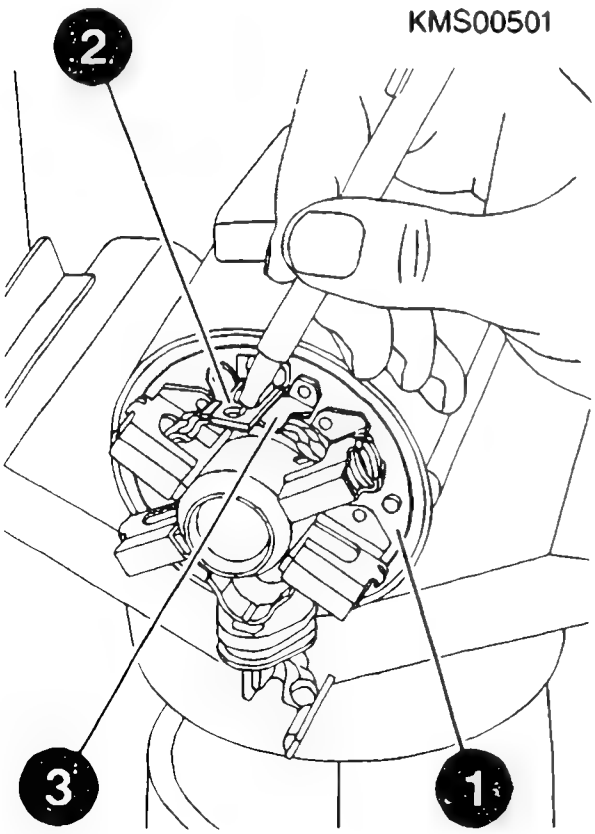
Replacing brush holder (bolted excitation winding connection)

Use three-square scraper to remove residual lacquer from stator frame at brush holder seat.
Insert new brush holder (1) with locating sleeve in stator frame.

Make sure locking device is properly positioned.
Place stranded connecting wire (2) on bracket (3) and mark position of hole on bracket (3).

Three-square scraper: comm. avail.

Continue: III11/1 Fig.: III10/2



COMPONENT CHECKING AND REPAIR

Replacing brush holder (bolted excitation winding connection)

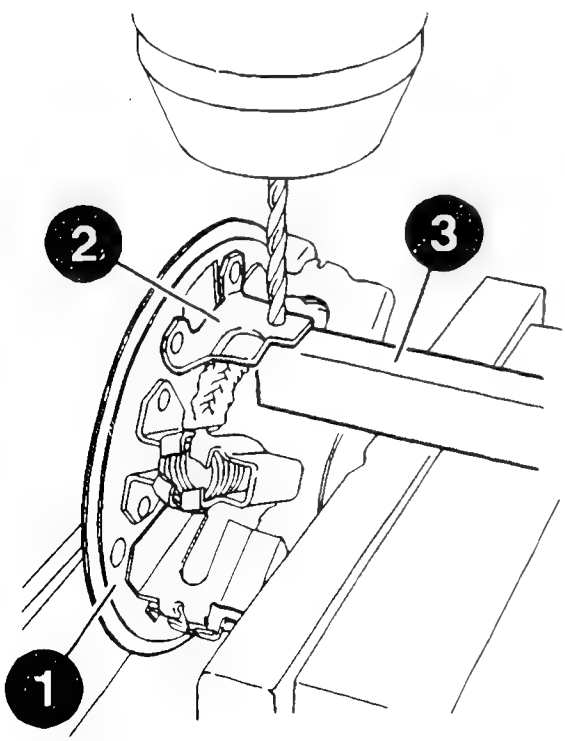
Detach brush holder (1) from stator frame and clamp carefully in machine vice so as to avoid damage.

Support bracket (2) with suitable rest (3).

Machine vice: comm. avail.

Continue: III12/1 Fig.: III11/2

KMS00492



COMPONENT CHECKING AND REPAIR

Replacing brush holder (bolted excitation winding connection)

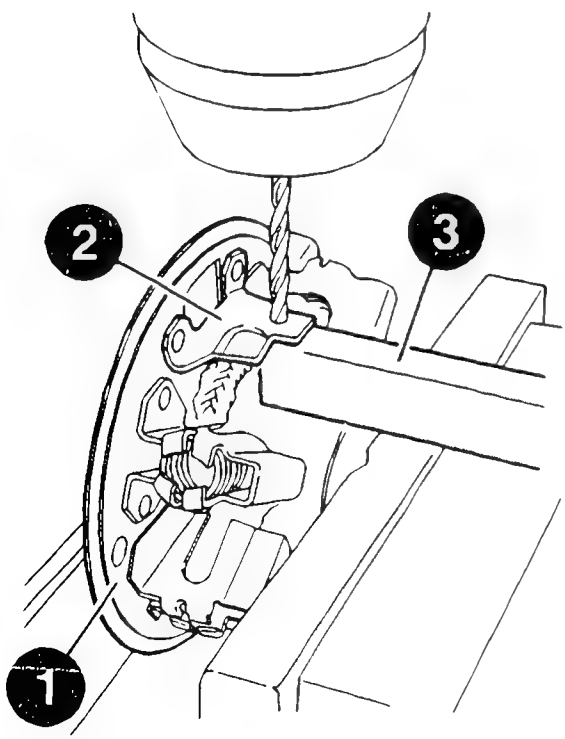
Drill hole of 5,5 mm diameter in bracket on column drill.
Pay attention to mark.

Deburr hole and clean brush holder with compressed air.

Column drill:	comm. avail.
HSS drill bit 5,5 mm:	comm. avail.

Continue: III13/1 Fig.: III12/2

KMS00492



COMPONENT CHECKING AND REPAIR

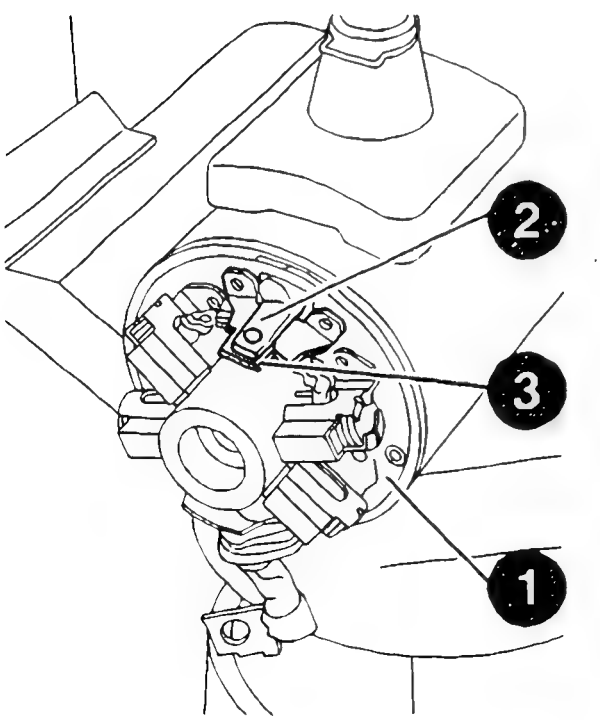
Replacing brush holder (bolted excitation winding connection)

Insert brush holder (1) with locating sleeve in stator frame. Pay attention to correct positioning of locking device.

Position stranded connecting wire (2) on bracket (3) and align.

Continue: III14/1 Fig.: III13/2

KMS00493



COMPONENT CHECKING AND REPAIR

Replacing brush holder (bolted excitation winding connection)

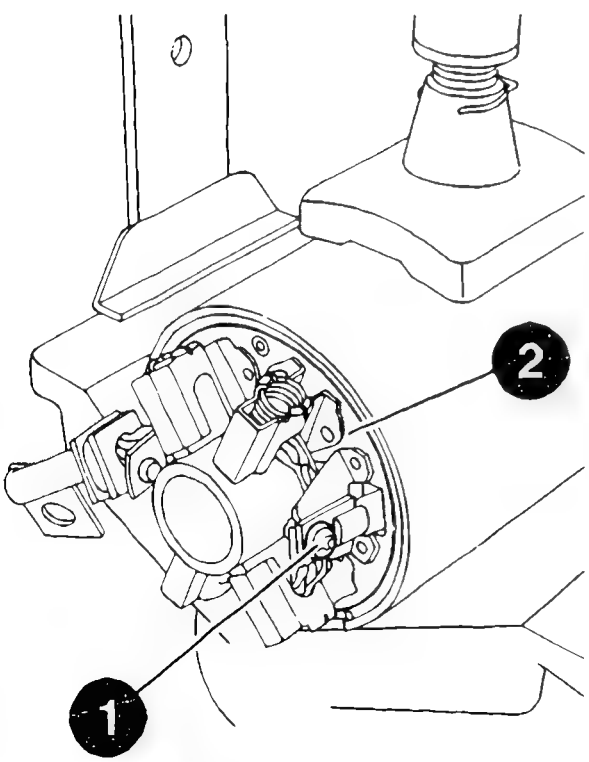
Attach connection of excitation winding (1) to brush holder (2). Use torque wrench.

ATTENTION: Make exclusive use of the fastening elements listed below.

Torque wrench:	comm. avail.
Tightening torque Excitation winding/brush holder connection:	3,3...4,1 Nm

Continue: III15/1 Fig.: III14/2

KMS00326



COMPONENT CHECKING AND REPAIR

Replacing brush holder
(bolted excitation winding connection)

Torx bolt:	old attachment
Spring lock washer DIN 127-B5:	comm. avail.
Hexagon nut M5 DIN 934-8:	comm. avail.

Continue: II10/2

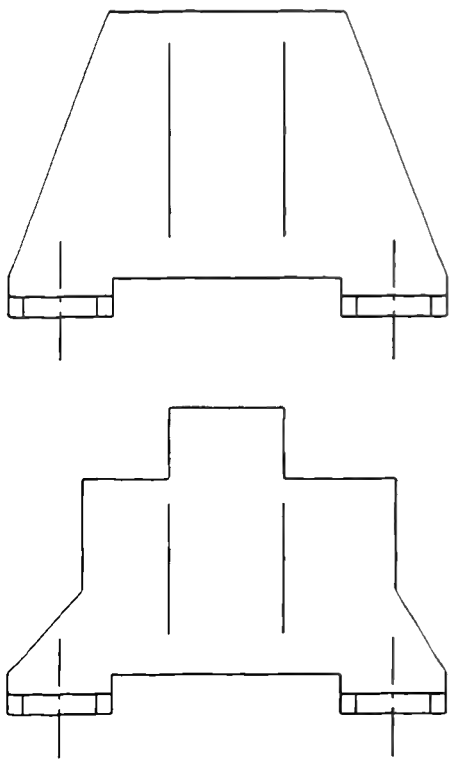
COMPONENT CHECKING AND REPAIR

Replacing brush holder (welded excitation winding connection)

NOTE: Replacement of the brush holder also necessitates replacement of the commutator end shield in the case of starting motors with a rectangular rubber seal in the commutator end shield (old version).
On replacing the brush holder, the welded joint between the excitation winding connection and the brush holder is to be replaced by a bolted joint.
Fig.: Old (top) and new version of bracket at brush holder

Continue: III17/1 Fig.: III16/2

KMS00487



COMPONENT CHECKING AND REPAIR

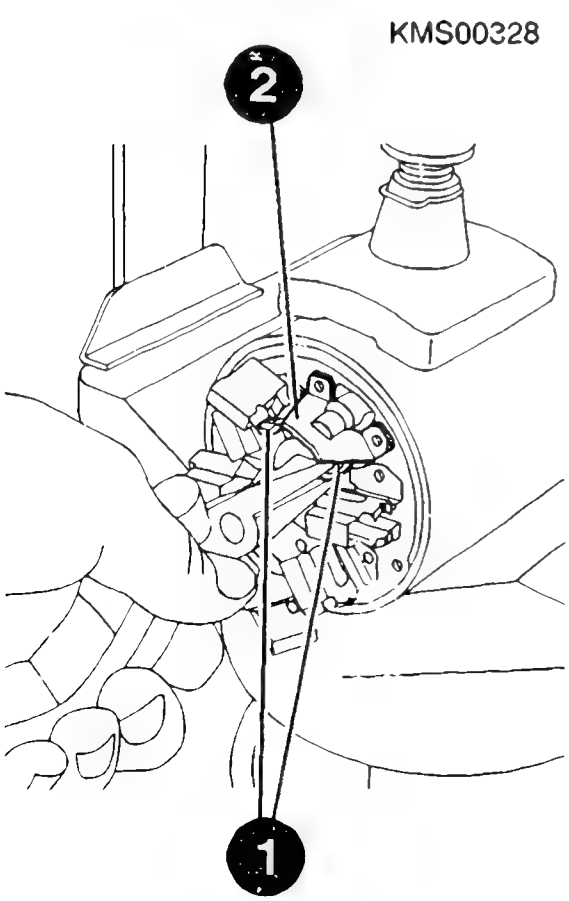
Replacing brush holder (welded excitation winding connection)

Pull out locating sleeve, pull carbon brushes out of tubular brush holder and remove helical compression springs.

Use flat-nose pliers to carefully peel off the welded-on stranded wires (1) of the two carbon brushes at the bracket (2) of the excitation winding connection.

Flat-nose pliers: comm. avail.

Continue: III18/1 Fig.: III17/2



COMPONENT CHECKING AND REPAIR

Replacing brush holder (welded excitation winding connection)

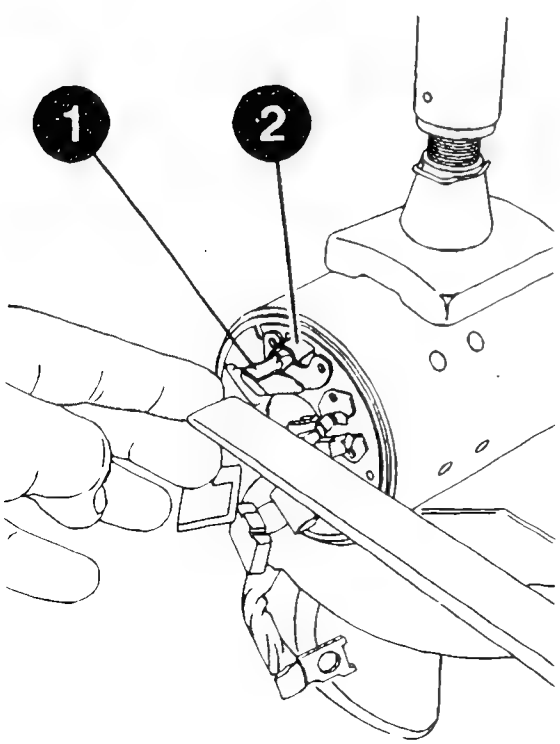
Use a flat file to produce a flat resting surface for the bolt head in the solid part of the stranded connecting wire (1).

The end of the stranded wire must coincide with the bracket.
Rework if necessary.
ATTENTION: Take care not to damage stranded wire and insulation (2).

Flat file: comm. avail.

Continue: III19/1 Fig.: III18/2

KMS00488



COMPONENT CHECKING AND REPAIR

Replacing brush holder (welded excitation winding connection)

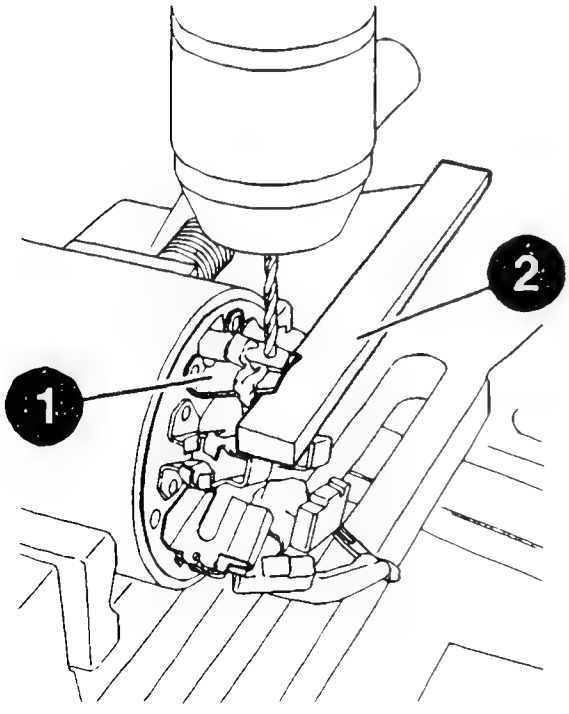
C a r e f u l l y clamp stator frame in machine vice so as not to damage stator frame.

Support bracket (1) with suitable rest (2).

Machine vice: comm. avail.

Continue: III20/1 Fig.: III19/2

KMS00489



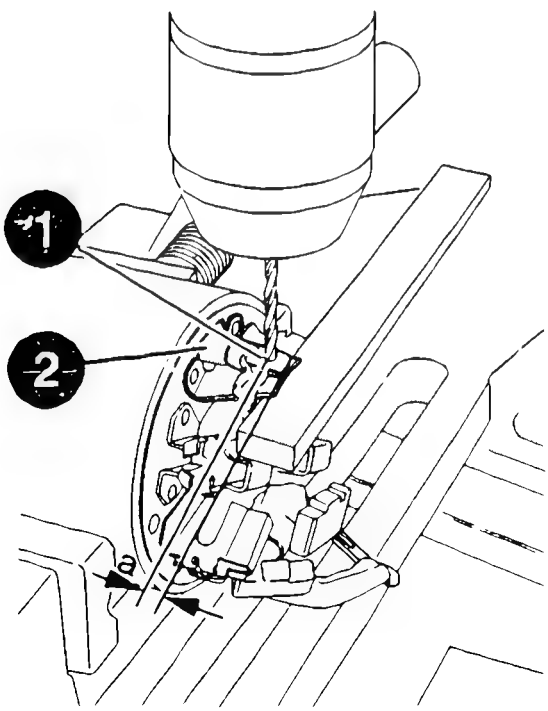
Replacing brush holder (welded excitation winding connection)

Drill a hole of 4,3 mm diameter as centrally as possible in the solid part of the stranded connecting wire (1) on a column drill.
Dimension "a" (between center of hole and top edge of stranded connecting wire) should be at least 3,5 mm.
ATTENTION: Take care not to damage stranded wire and insulation (2).

Column drill: comm. avail.
HSS drill bit 4,3 mm: comm. avail.

Continue: III21/1 Fig.: III20/2

KMS00490



COMPONENT CHECKING AND REPAIR

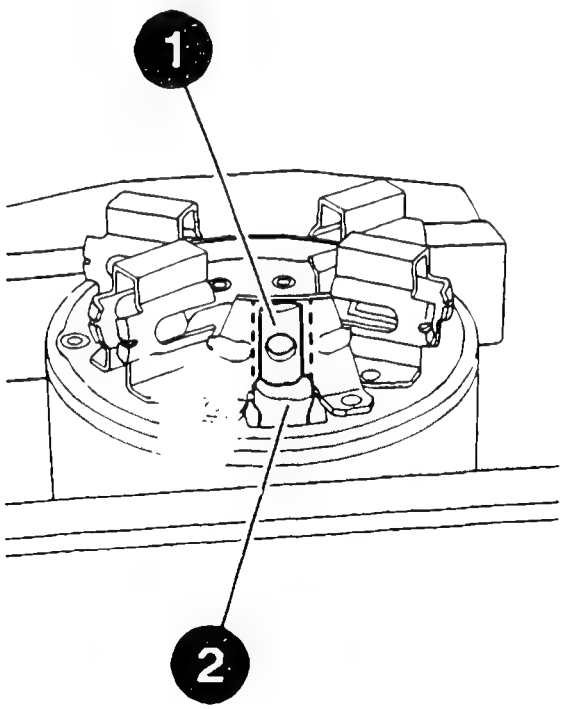
Replacing brush holder (welded excitation winding connection)

Carefully clamp stator frame in vice between soft jaws. Saw (mark, Fig.) into bracket along welded-on stranded wire (1). The two cuts must always be at least 1.5 mm from the edge of the hole.
ATTENTION: Take care not to damage stranded wire and insulation (2).

Hacksaw: comm. avail.

Continue: III22/1 Fig.: III21/2

KMS00329



COMPONENT CHECKING AND REPAIR

Replacing brush holder (welded excitation winding connection)

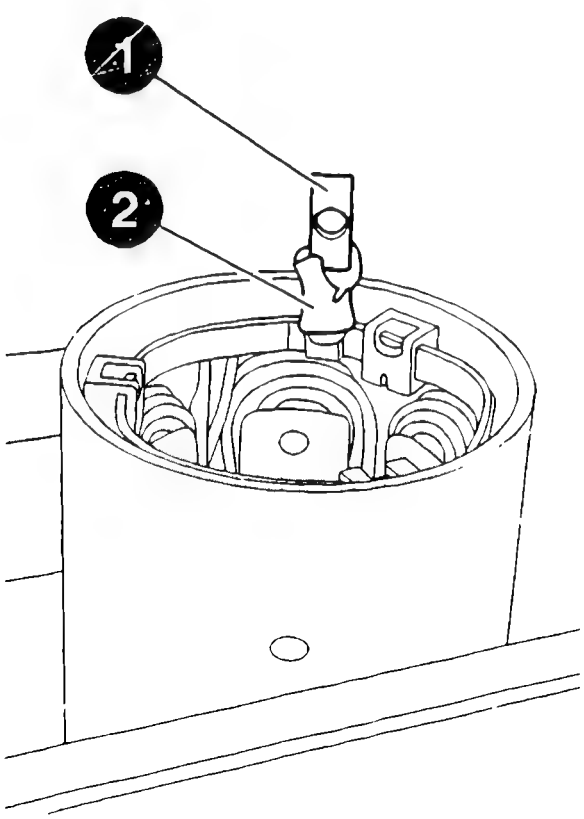
Detach old brush holder.

Deburr connection (1) of excitation winding and remove welding residue on contact surface.

ATTENTION:
Take care not to damage insulation of stranded connecting wire of excitation winding (2).

Continue: III23/1 Fig.: III22/2

KMS00330



COMPONENT CHECKING AND REPAIR

Replacing brush holder (welded excitation winding connection)

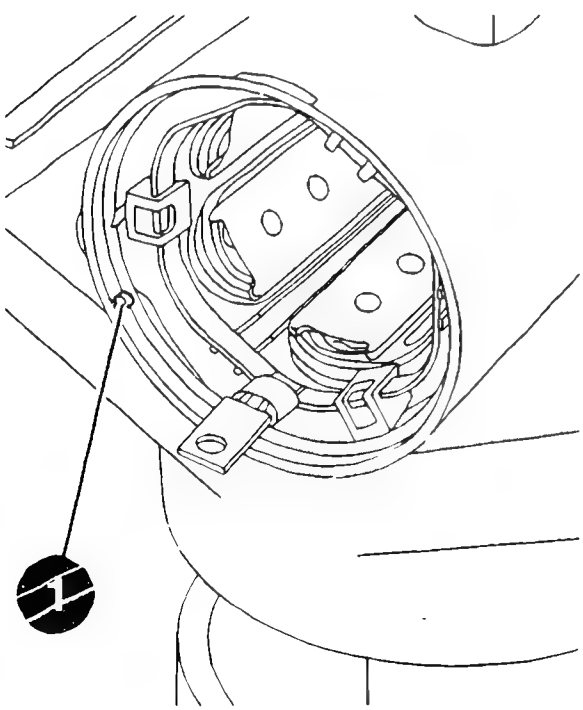
NOTE: The new brush holder must be provided with a recess for the locking device in the case of starting motors with a rectangular rubber seal in the commutator end shield (old version).

Clamp stator frame in clamping support. Mark position of locking lug (1) at end face of stator frame.

Clamping support: 0 986 619 362

Continue: III24/1 Fig.: III23/2

KMS00508

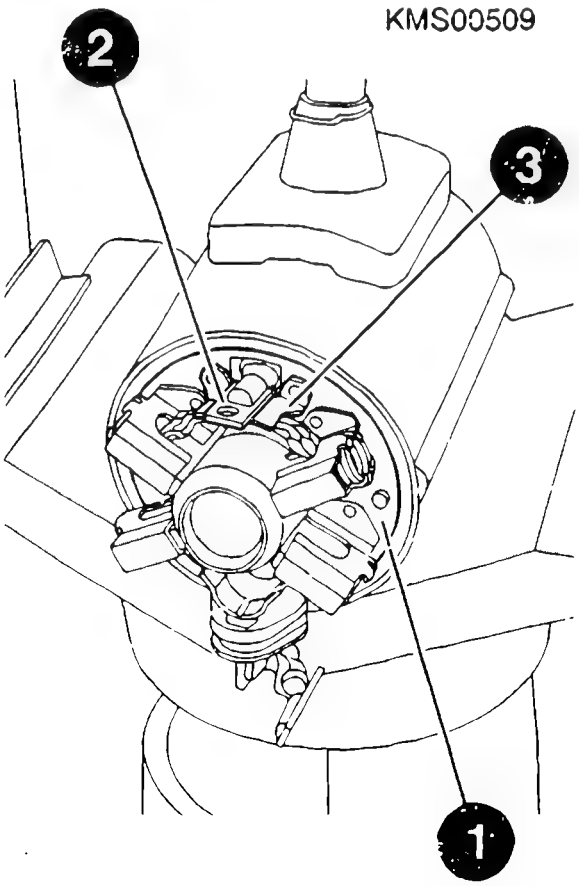


Replacing brush holder (welded excitation winding connection)

Insert new brush holder (1) in stator frame such that stranded connecting wire (2) rests centrally on bracket (3).

Transfer lug position mark from stator frame to brush holder.

Continue: III25/1 Fig.: III24/2



COMPONENT CHECKING AND REPAIR

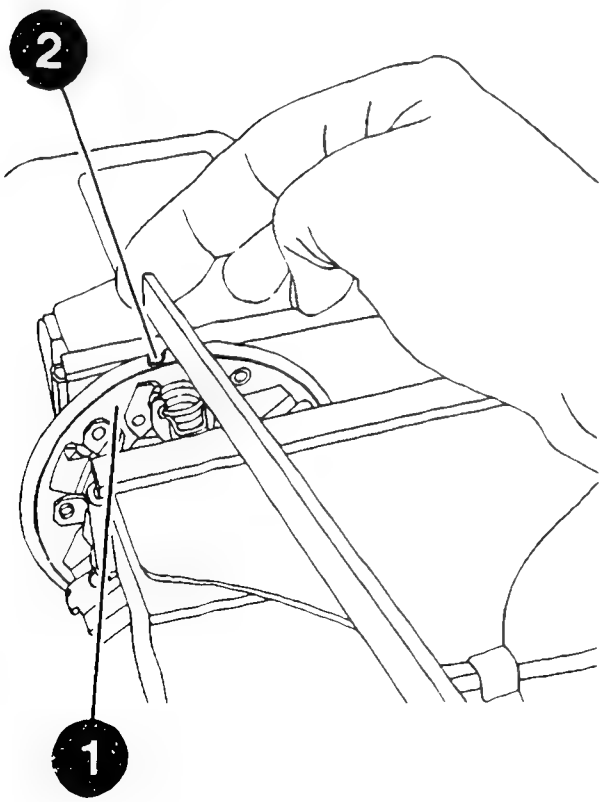
Replacing brush holder (welded excitation winding connection)

C a r e f u l l y clamp brush holder (1) in vice between soft jaws. Use flat file to make 3 mm wide and 1.5 mm deep recess (2) in brush holder.
ATTENTION: Take care not to damage brush holder, in particular insulation and tubular brush holders.
Then clean brush holder with compressed air.

Flat file: comm. avail.

Continue: III26/1 Fig.: III25/2

KMS00510



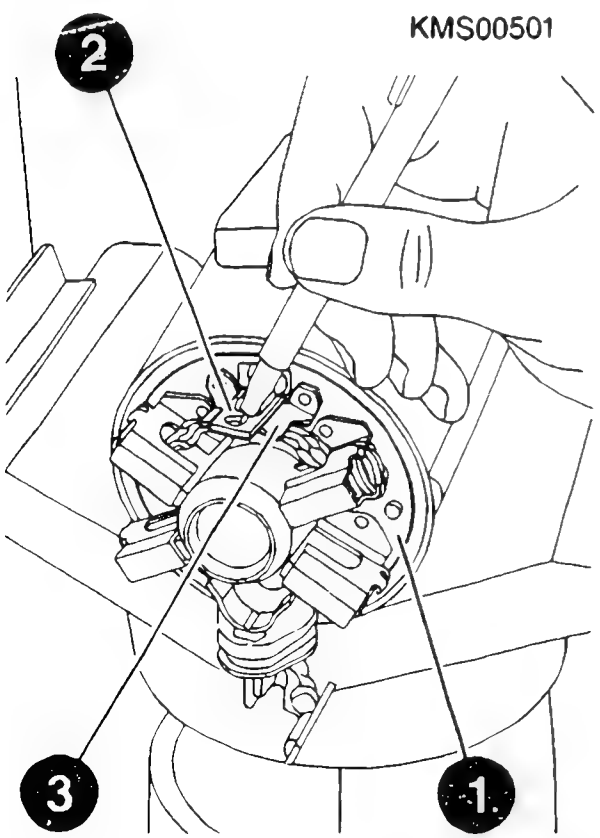
COMPONENT CHECKING AND REPAIR

Replacing brush holder (welded excitation winding connection)

Use three-square scraper to remove residual lacquer from stator frame at brush holder seat.
Insert new brush holder (1) with locating sleeve in stator frame.
Pay attention to correct positioning of locking device.
Place stranded connecting wire (1) on bracket (2) and mark position of hole on bracket (2).

Three-square scraper: comm. avail.

Continue: III27/1 Fig.: III26/2



COMPONENT CHECKING AND REPAIR

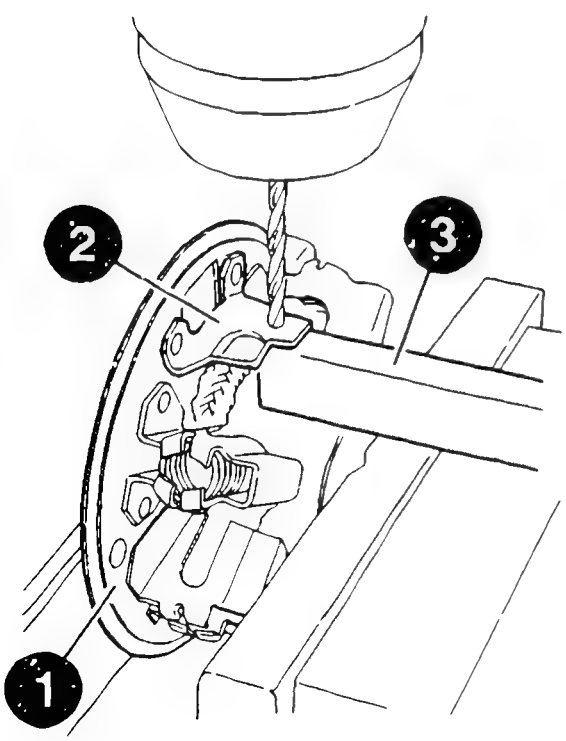
Replacing brush holder (welded excitation winding connection)

Detach brush holder (1) from stator frame and clamp carefully in machine vice so as to avoid damage. Support bracket (2) with suitable rest (3).

Machine vice: comm. avail.

Continue: III28/1 Fig.: III27/2

KMS00492



COMPONENT CHECKING AND REPAIR

Replacing brush holder (welded excitation winding connection)

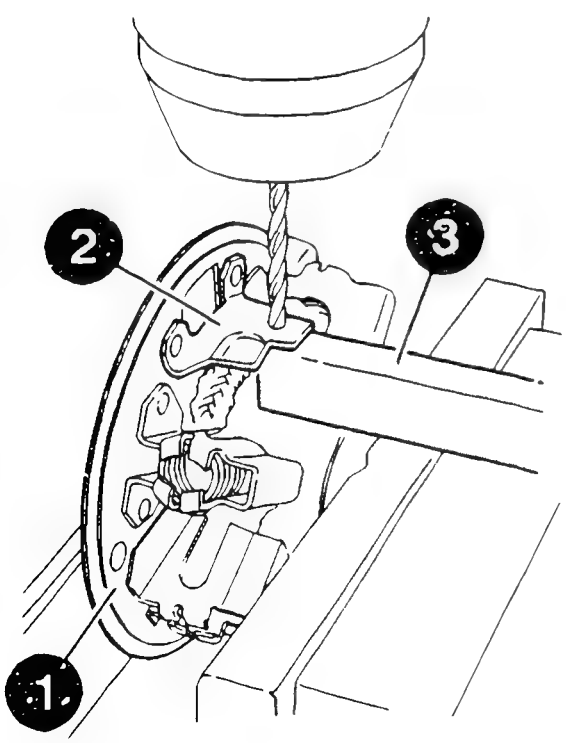
Drill hole of 5,5 mm diameter in bracket on column drill. Pay attention to mark.

Deburr hole and clean brush holder with compressed air.

Column drill:	comm. avail.
HSS drill bit 5,5 mm:	comm. avail.

Continue: IV01/1 Fig.: III28/2

KMS00492



COMPONENT CHECKING AND REPAIR

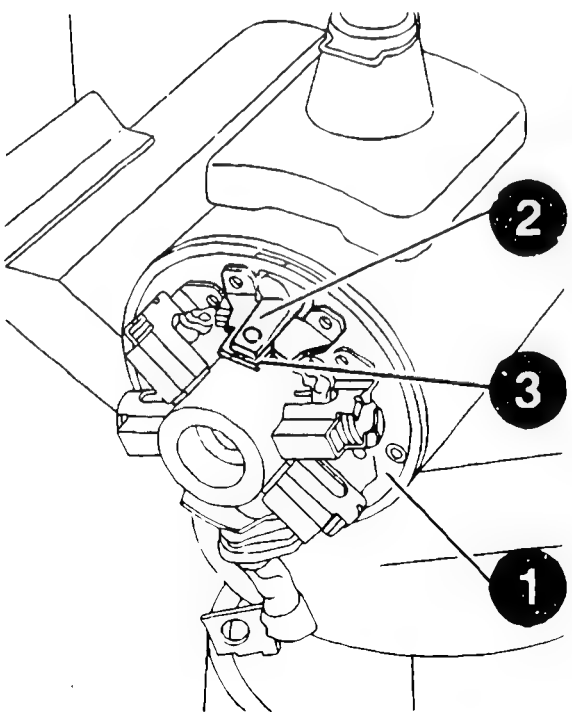
Replacing brush holder
(welded excitation winding connection)

Insert brush holder (1) with locating sleeve in stator frame. Pay attention to correct positioning of locking device.

Position stranded connecting wire (2) on bracket (3) and align.

Continue: IV02/1 Fig.: IV01/2

KMS00493



COMPONENT CHECKING AND REPAIR

Replacing brush holder
(welded excitation winding connection)

ATTENTION: DANGER OF SHORT TO GROUND
Make exclusive use of stated fasteners.

NOTE: Collar must not protrude above top edge of bracket.
Rework if necessary.

Continue: IV02/2

COMPONENT CHECKING AND REPAIR

Replacing brush holder
(welded excitation winding connection)

Hexagon bolt M4x10 DIN 933-8.8:	comm. avail.
Spring lock washer DIN 127-B4:	comm. avail.
Hexagon nut M4 DIN 934-8:	comm. avail.

Continue: IV03/1

COMPONENT CHECKING AND REPAIR

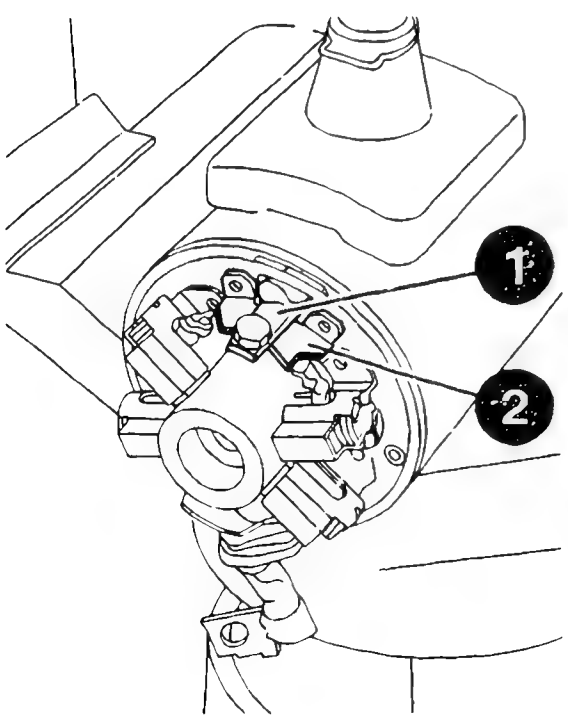
Replacing brush holder (welded excitation winding connection)

Screw stranded connecting wire (1) to new brush holder.
Standard connecting wire must make full contact with bracket (2) of brush holder. Rework if necessary.
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	3,3...4,1 Nm

Continue: II10/2 Fig.: IV03/2

KMS00373



COMPONENT CHECKING AND REPAIR

Checking excitation winding

Use tester and test prods to check winding for continuity between stranded connecting wire (1) and bright part of stator frame.

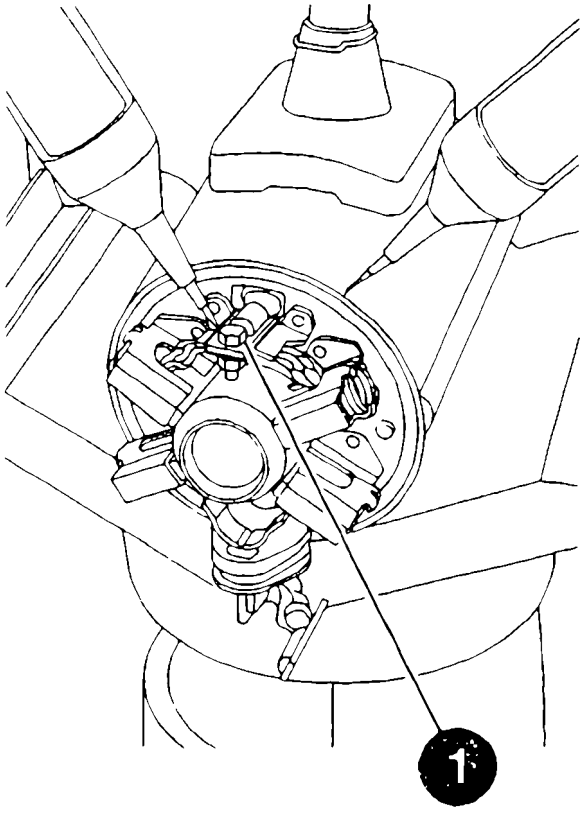
Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101

Continuity test voltage: 40 V*

* = AC

Continue: IV05/1 Fig.: IV04/2

KMS00500



COMPONENT CHECKING AND REPAIR

Checking excitation winding

Entire stator frame is to be replaced in the event of defective, scorched, unsoldered or loose windings.

Continue: II10/2

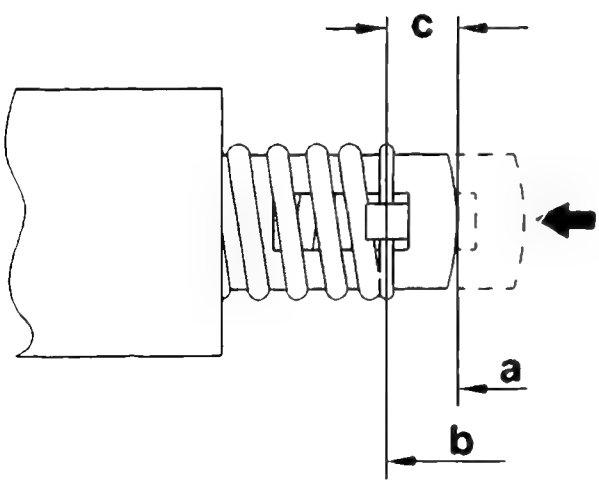
COMPONENT TESTING AND REPAIR

Testing solenoid switch

Examine solenoid switch for damage.
Check burn-off reserve.
Press in armature by hand until current bridge is resting (a) on terminal stud. On pressing in the armature further as far as stop (b) a noticeable increase in force is apparent. The difference between positions (a) and (b) is the burn-off reserve (c). If there is no further burn-off reserve, the solenoid switch must be replaced.

Continue: IV07/1 Fig.: IV06/2

KMS00303



COMPONENT CHECKING AND REPAIR

Checking solenoid switch

Use tester to check resistance of pull-in winding (term. 50/term. 45).

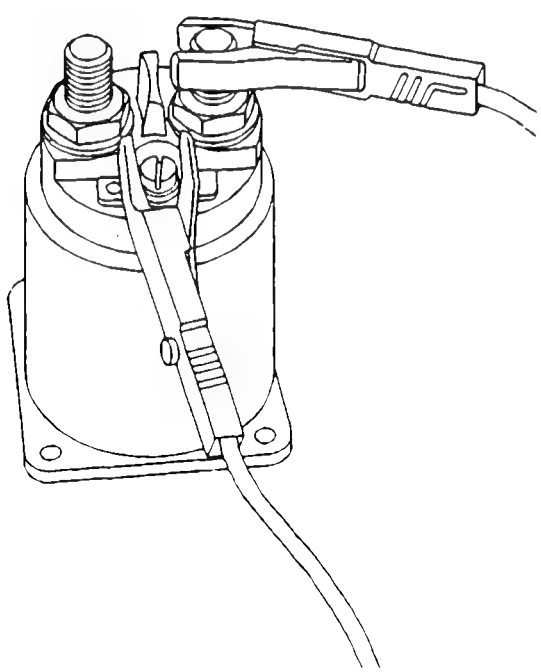
Alternator tester:	0 684 201 200

Resistance values

12V starting motor 0 001 230 ...:	0,2...0,25 Ohm
24V starting motor 0 001 231 ... depending on version:	1,0...1,1 Ohm 1,2...1,4 Ohm

Continue: IV08/1 Fig.: IV07/2

KMS00239



COMPONENT CHECKING AND REPAIR

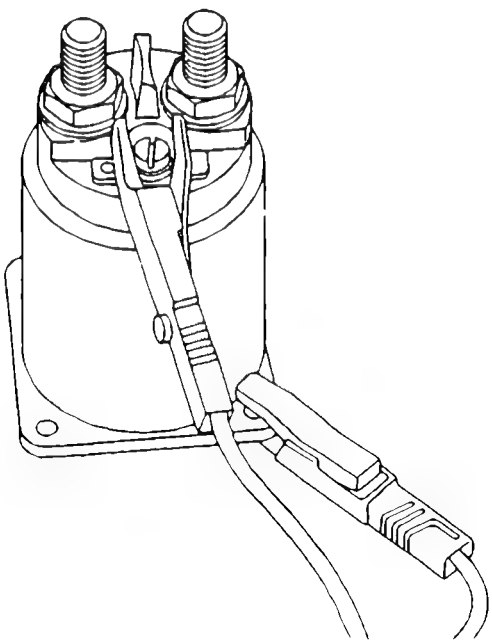
Checking solenoid switch

Use tester to check resistance of holding winding (term. 50/ground).

Alternator tester:	0 684 201 200
Resistance values	
12V starting motor	
0 001 230 ...:	1,0...1,1 Ohm
24V starting motor	
0 001 231 ...	
depending on version:	3,2...3,6 Ohm
	4,1...4,6 Ohm

Continue: IV09/1 Fig.: IV08/2

KMS00240



COMPONENT TESTING AND REPAIR

Testing solenoid switch

Neither the tests described, nor proper functioning of the solenoid switch when testing the function of the starting motor following repairs can provide reliable information on long-term trouble-free operation of the solenoid switch.
It is therefore advisable to renew the solenoid switch when the starting motor is repaired.

Continue: II10/2

STARTING MOTOR ASSEMBLY TABLE

Continue: IV10/2

STARTING MOTOR ASSEMBLY TABLE

Continue: I01/1

STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive

Lubricate in line with lubrication schedule before and during starting motor assembly.

During assembly of overrunning-clutch drive, secure cover of planetary gear train to stop it dropping off.

Continue: IV12/1

STARTING MOTOR ASSEMBLY

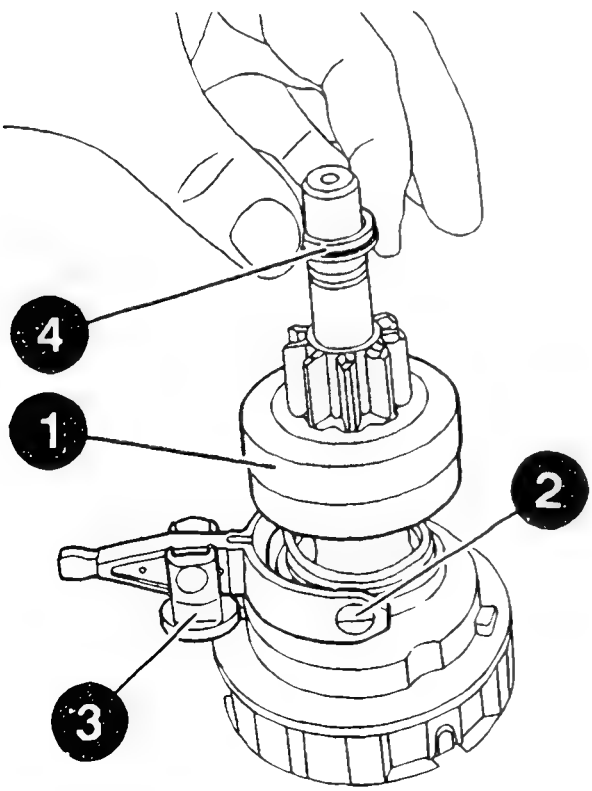
Assembling overrunning-clutch drive

Slip overrunning-clutch drive (1) with fork lever (2) and bearing pedestal (3), as well as new stop ring (4) onto drive shaft.
ATTENTION: Spiral spline of drive must be dry and free of grease to stop drive shaft becoming pasty. Only apply grease to spiral spline on drive shaft.

Grease VS 10832-Ft: 5 932 240 000

Continue: IV13/1 Fig.: IV12/2

KMS00333



STARTING MOTOR ASSEMBLY

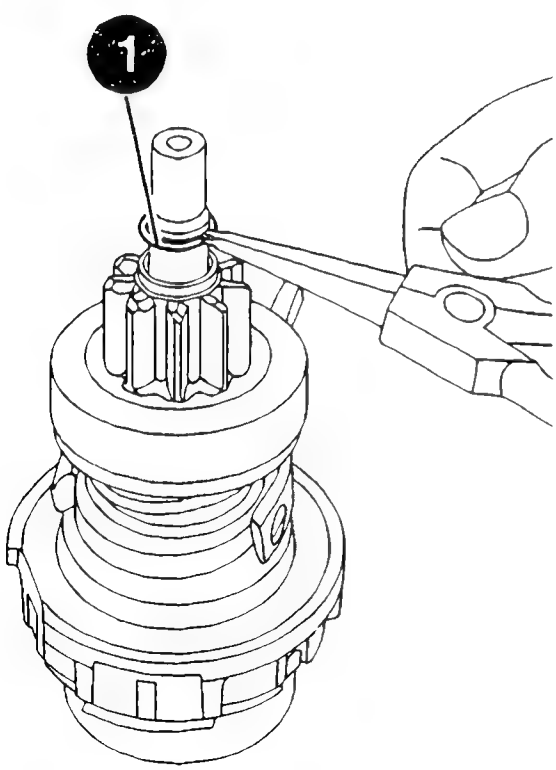
Assembling overrunning-clutch drive

Bend open new circlip (1) with pliers and insert in annular groove.
Use gripping pliers to squeeze circlip together in annular groove.
ATTENTION: Take care not to damage drive shaft when doing so.

Circlip pliers:	comm. avail.
Gripping pliers:	comm. avail.

Continue: IV14/1 Fig.: IV13/2

KMS00512



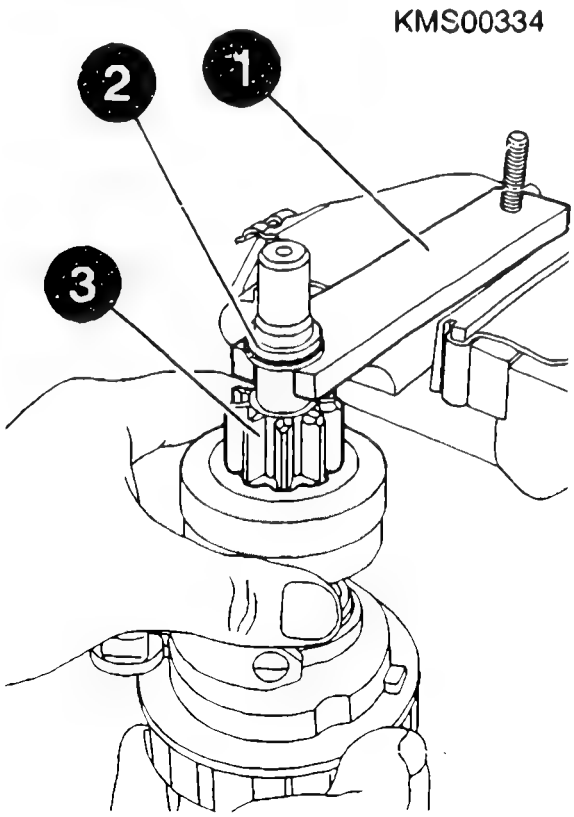
STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive

Clamp holder (1) in vice.
Detach planetary gear train with overrunning-clutch drive from assembly stand and insert in holder such that holder is between stop ring (2) and pinion (3).
Pay attention to correct positioning of stop ring in holder.

Holder: 0 986 617 215

Continue: IV15/1 Fig.: IV14/2



STARTING MOTOR ASSEMBLY

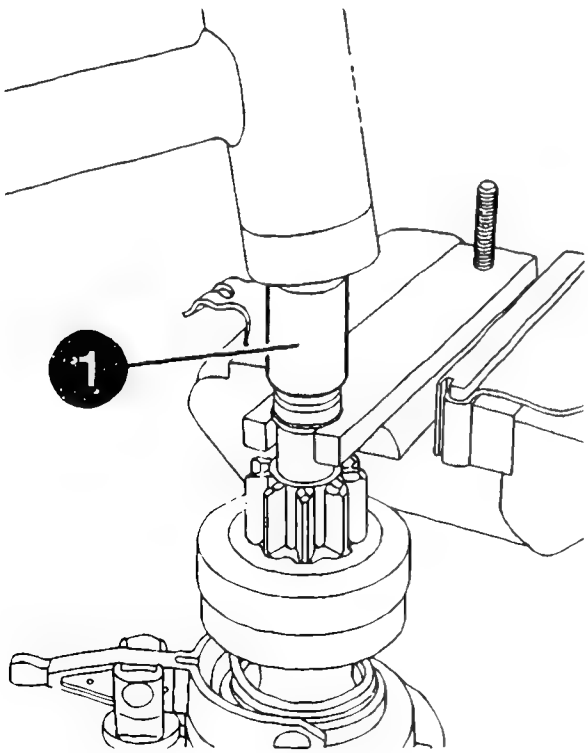
Assembling overrunning-clutch drive

Slip assembly sleeve (1) onto drive shaft such that machined side of sleeve faces circlip. Tap firmly (plastic-headed hammer) on assembly sleeve to engage circlip beneath stop ring. Detach assembly sleeve, remove assembly from holder, slip onto assembly stand and position vertically.

Assembly sleeve:	0 986 617 113
Assembly stand (reworked):	0 986 617 138

Continue: IV10/1 Fig.: IV15/2

KMS00335



STARTING MOTOR ASSEMBLY

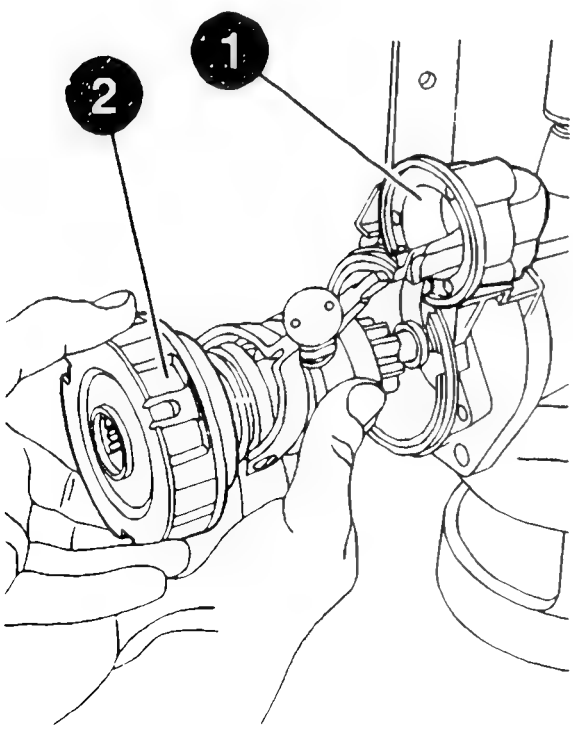
Assembling overrunning-clutch drive and planetary gear train

Mount drive-end bearing (1) in clamping support.
Detach planetary gear train (2) assembly from stand and insert in drive-end bearing.

Clamping support: 0 986 619 362

Continue: IV17/1 Fig.: IV16/2

KMS00336



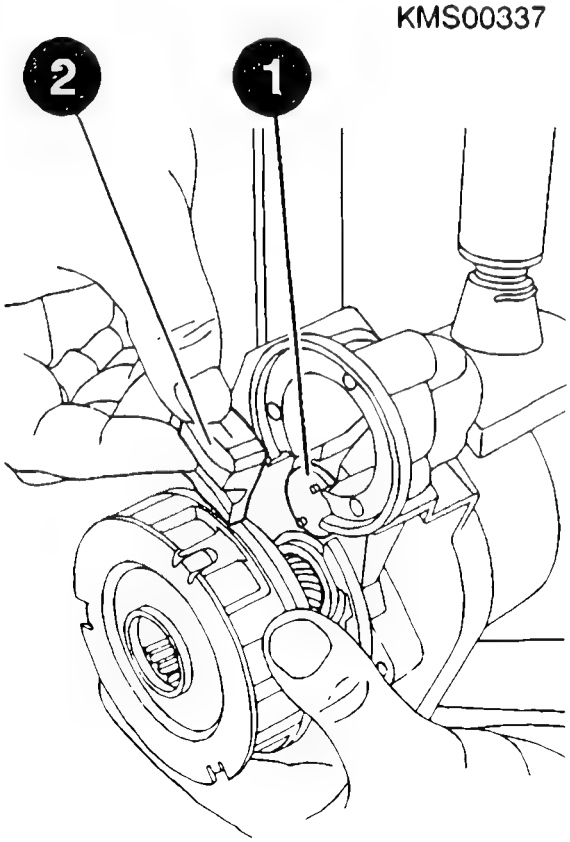
STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive and planetary gear train

Insert bearing pedestal (1) of fork lever in mount in drive-end bearing.
Insert rubber seal (2).
Make sure rubber seal is properly positioned.
Ensure correct positioning of locking device of planetary gear train in drive-end bearing.
NOTE: Recess in planetary gear train must be in line with bearing pedestal of fork lever.

Continue: IV10/1 Fig.: IV17/2

KMS00337



STARTING MOTOR ASSEMBLY

Assembling armature

Mount stator frame in clamping support. Slip armature into stator frame from drive-end bearing side until armature shaft is positioned in hole in locating sleeve in brush holder.
ATTENTION: Take care not to damage excitation winding.

Clamping support: 0 986 619 362

Continue: IV19/1

STARTING MOTOR ASSEMBLY

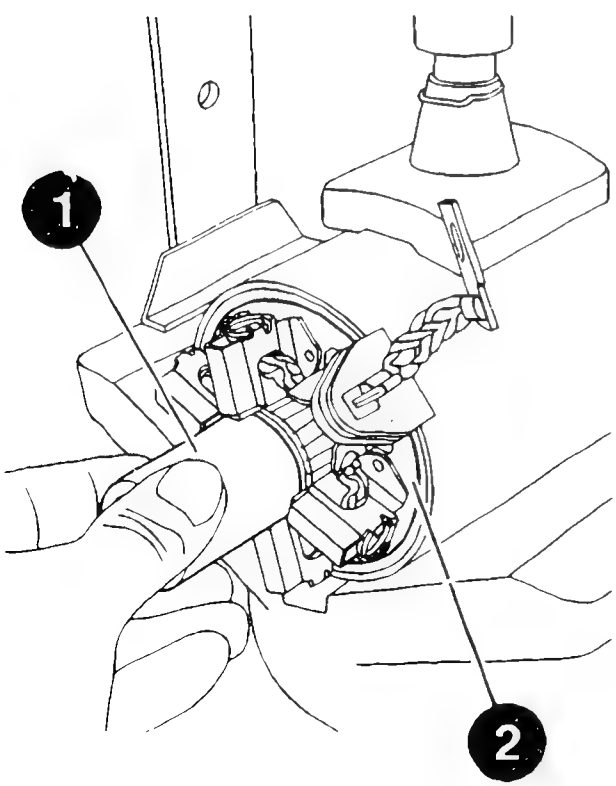
Assembling armature

Push armature further in, whilst at the same time pulling locating sleeve (1) out of brush holder. The carbon brushes must rest on the commutator.
Check brush holder (2) for correct positioning (locking device) in stator frame.

A T T E N T I O N:
Take care not to damage insulation of excitation winding connection.

Continue: IV10/1 Fig.: IV19/2

KMS00502



STARTING MOTOR ASSEMBLY

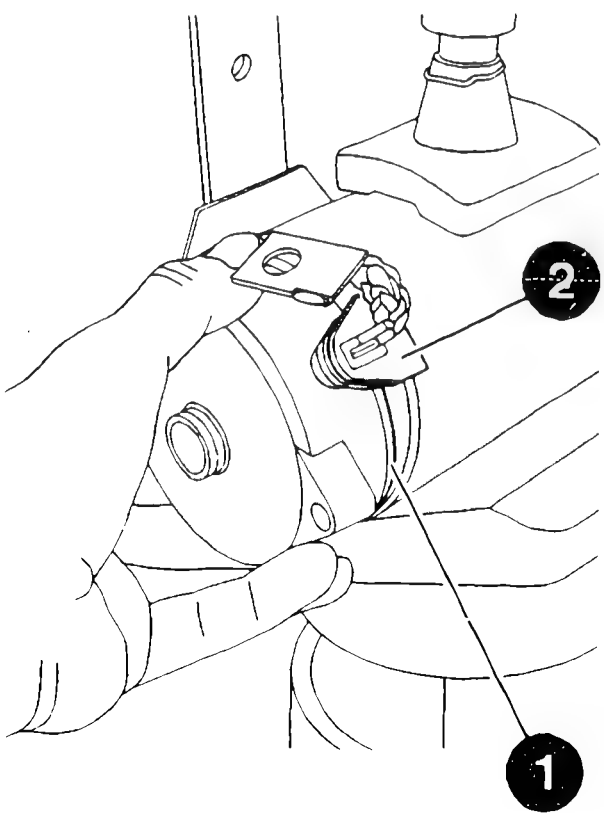
Assembling commutator end bearing

Clean fitting surfaces at commutator end shield (1) and in stator frame with three-square scraper. Mount commutator end shield on stator frame whilst providing support for armature from drive-end bearing side. Pay attention to locking device. Ensure correct positioning of commutator end shield and rubber seal (2) at connection, term. 45.

Three-square scraper: comm. avail.

Continue: IV21/1 Fig.: IV20/2

KMS00495



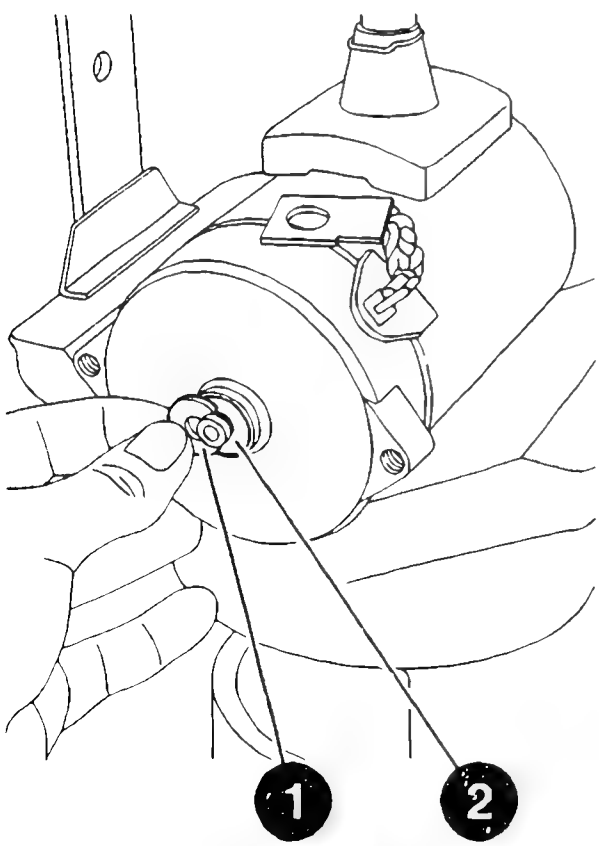
STARTING MOTOR ASSEMBLY

Assembling commutator end shield

Slip new shim (2) onto armature shaft and insert retaining collar (1) in annular groove.

Continue: IV10/1 Fig.: IV21/2

KMS00305



STARTING MOTOR ASSEMBLY

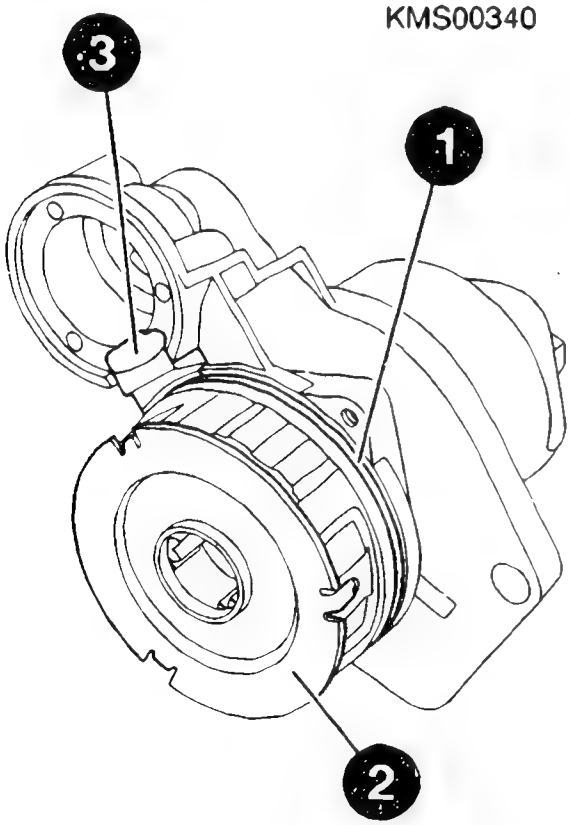
Assembling drive-end bearing

Clean fitting surface (1) at drive-end bearing with three-square scraper. Check correct positioning of planetary gear train (2) and rubber seal (3) in drive-end bearing.

Three-square scraper: comm. avail.

Continue: IV23/1 Fig.: IV22/2

KMS00340



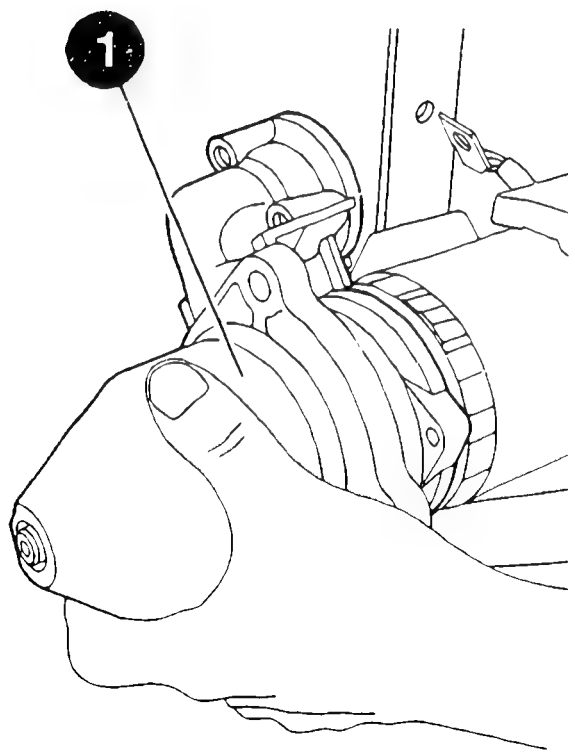
STARTING MOTOR ASSEMBLY

Assembling drive-end bearing

Slide pre-assembled drive-end bearing into stator frame whilst supporting commutator end shield. Slight turning of the entire drive-end bearing unit (1) facilitates meshing of the sun gear of the armature shaft in the planet gears of the planetary gear train.
Pay attention to mark.

Continue: IV24/1 Fig.: IV23/2

KMS00341



STARTING MOTOR ASSEMBLY

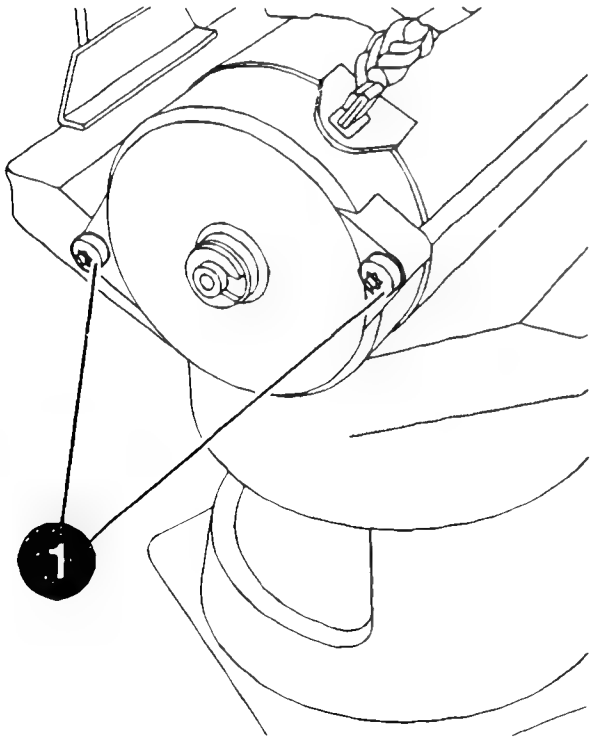
Assembling drive-end bearing

Slacken off clamping support, re-check correct positioning of drive-end bearing and commutator end shield (mark/locking device) and secure.
The bolts (1) must run in parallel with the imaginary center axis of the starting motor and be tightened alternately and evenly.
Use torque wrench.

Torx T30 bit socket:	comm. avail.
Torque wrench:	comm. avail.
Tightening torque:	8,9...11,1 Nm

Continue: IV10/1 Fig.: IV24/2

KMS00499



STARTING MOTOR ASSEMBLY

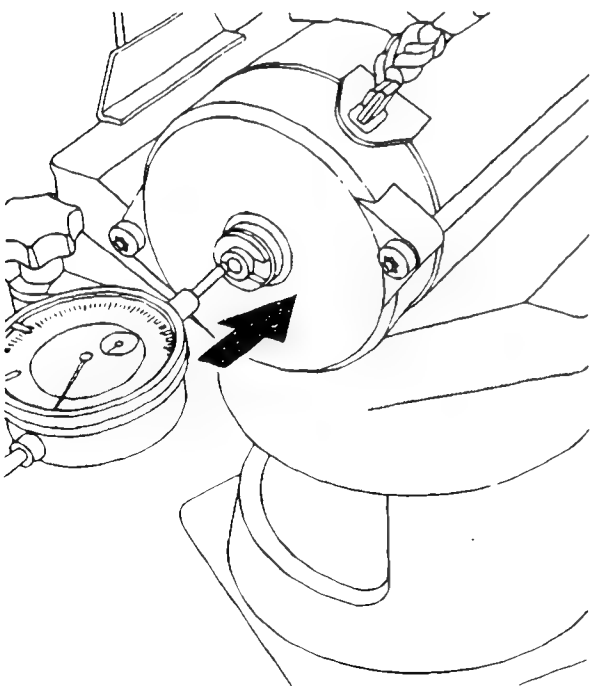
Checking and adjusting armature axial clearance

Slide home armature in direction of drive-end bearing (see arrow).

Apply dial gauge at end face of armature shaft and set to "ZERO".

Continue: IV26/1 Fig.: IV25/2

KMS00498



STARTING MOTOR ASSEMBLY

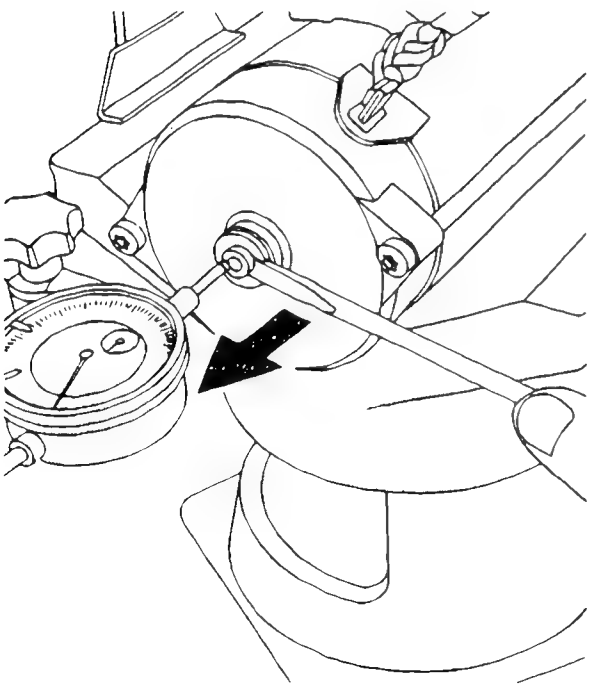
Checking and adjusting armature axial clearance

Move armature in direction of commutator end shield as far as it will go, read off armature axial clearance.
If armature axial clearance is outside stated range, adjustment must be made using an appropriate shim.
Then check armature axial clearance again.
Check freedom of movement of armature.

Armature axial clearance: 0,05...0,7 mm

Continue: IV10/1 Fig.: IV26/2

KMS00497



STARTING MOTOR ASSEMBLY

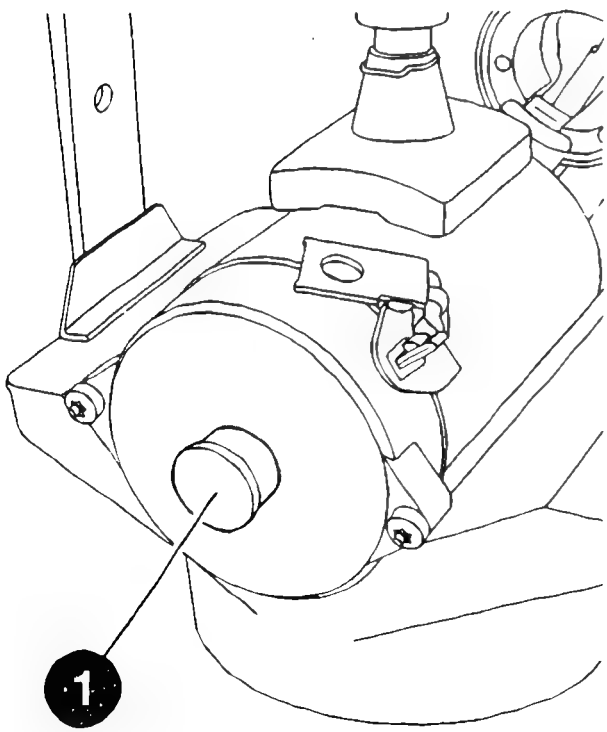
Fitting cap

Fill 1/3 of cap (plastic) (1) with grease and press onto commutator end shield.
Cap can also be fitted by tapping it gently with a plastic-headed hammer.

Grease VS 10832-Ft: 5 932 240 000

Continue: IV10/2 Fig.: IV27/2

KMS00496



STARTING MOTOR ASSEMBLY

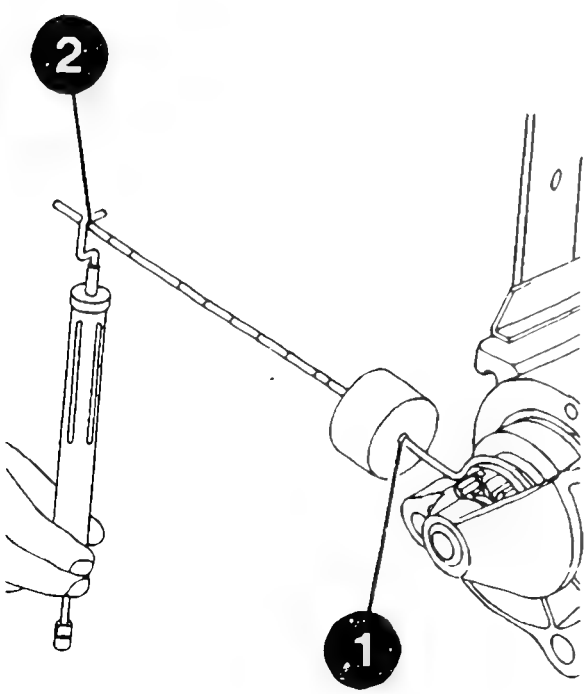
Checking armature braking torque

Hook torquemeter in position at pinion in line with direction of operation of starting motor and move to horizontal position.
Shift weight to second mark 2.0 (1).
Hook in spring balance at last mark 8 (2).
ATTENTION: Torquemeter must not make contact with drive-end bearing during test.

Torquemeter:	0 986 617 206
Spring balance:	0 986 619 181

Continue: V01/1 Fig.: IV28/2

KMS00388



STARTING MOTOR ASSEMBLY

Checking armature braking torque

Pull on spring balance until pinion with armature starts to turn.

Take scale reading on spring balance. Value must be 0,3...0,7 kg.

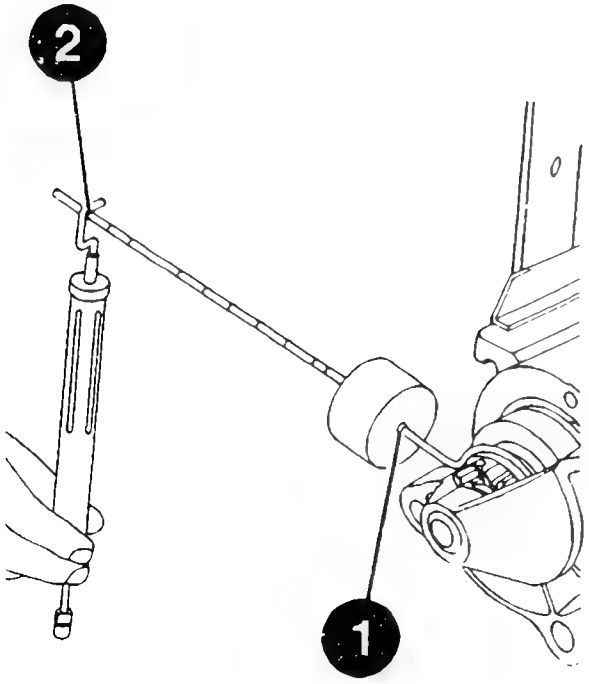
The armature braking torque is then within the required range.

If this is not the case, check components and their assembly.

Armature braking torque: 1,1...2,1 Nm

Continue: IV10/2 Fig.: V01/2

KMS00388



STARTING MOTOR ASSEMBLY

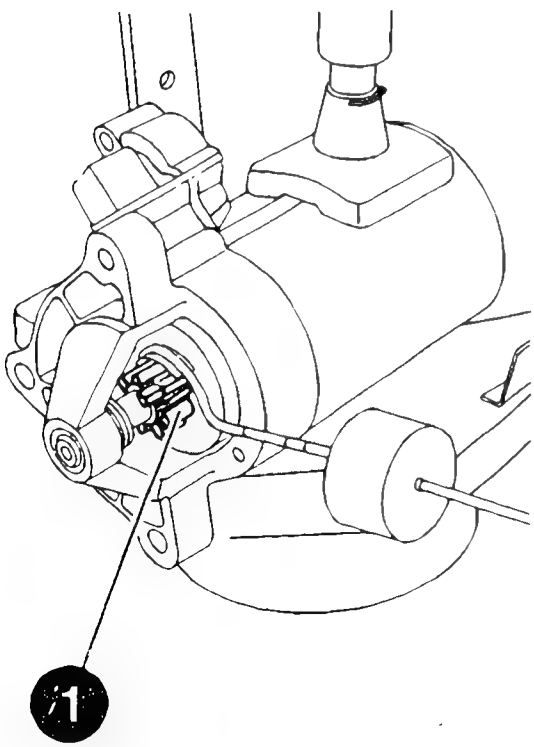
Checking overrunning clutch torque

Insert Torx bit socket, for example, in pinion to guarantee (1) proper positioning of torquemeter.
Engage torquemeter at pinion in line with direction of operation of starting motor and move to horizontal position.

Torquemeter: 0 986 617 206

Continue: V03/1 Fig.: V02/2

KMS00389



STARTING MOTOR ASSEMBLY

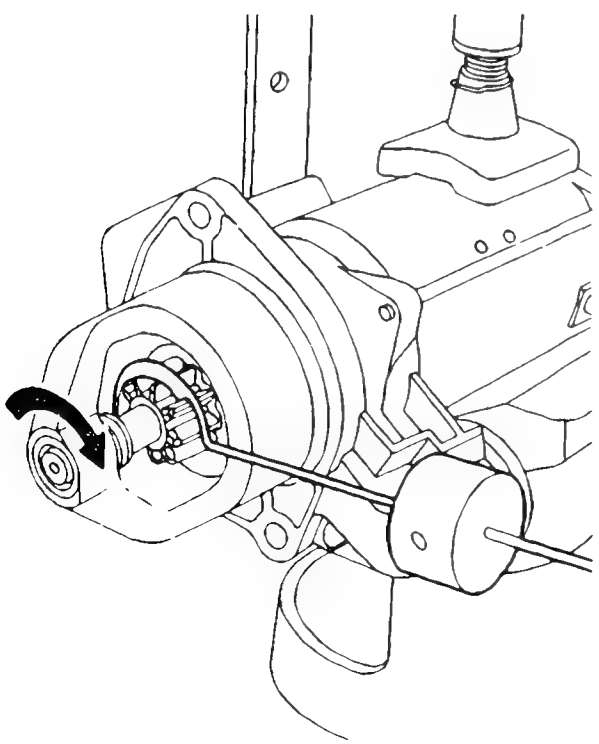
Checking overrunning clutch torque

Shift weight until pinion starts to turn. Scale reading must be 3,5...6,5.
This corresponds to an overrunning torque of 0,35...0,65 Nm.
ATTENTION: Torquemeter must not make contact with drive-end bearing during test.

Overrunning torque: 0,35...0,65 Nm

Continue: IV10/2 Fig.: V03/2

KMS00345



STARTING MOTOR ASSEMBLY

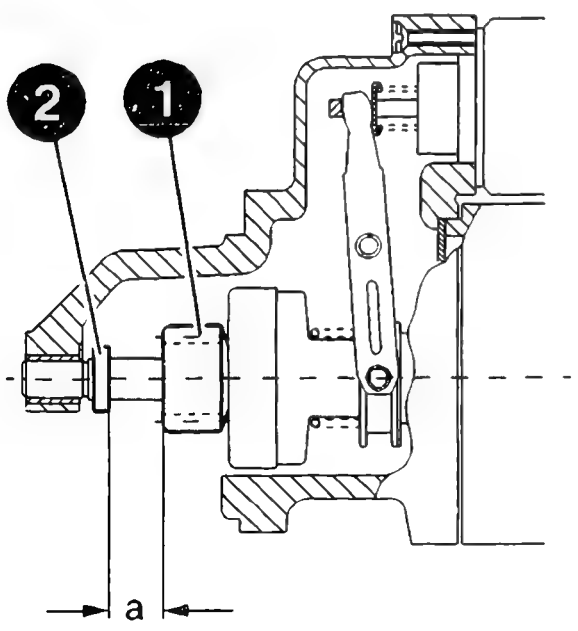
Checking total pinion travel

Measure meshing travel between pinion (1) (at rest) and stop ring (2).

Total pinion travel a
Depending on version: 17...19 mm

Continue: IV10/2 Fig.: V04/2

KMS00288



STARTING MOTOR ASSEMBLY

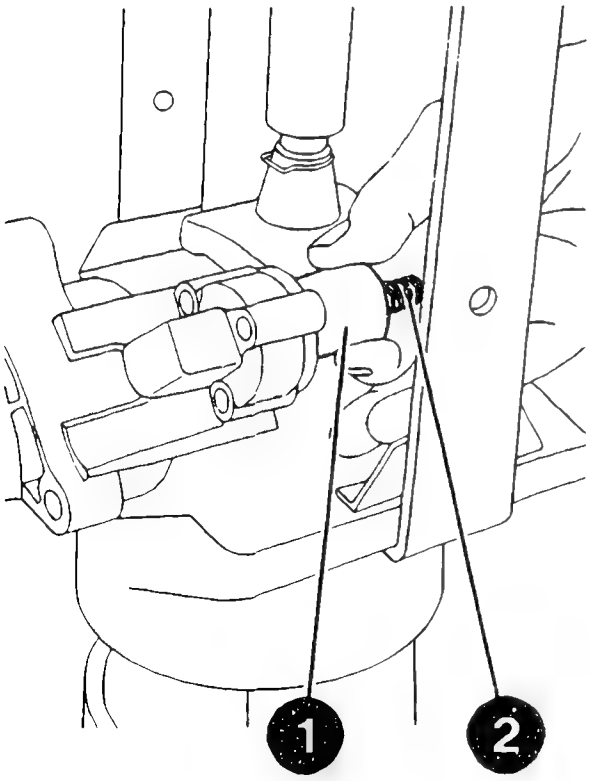
Assembling solenoid switch

Press pinion against stop ring, hook relay armature (1) into engaging lever and grease slightly around periphery. Pay attention to return spring (2) in relay armature.

Gleitmo 1580 V: 5 996 328 000

Continue: V06/1 Fig.: V05/2

KMS00350



STARTING MOTOR ASSEMBLY

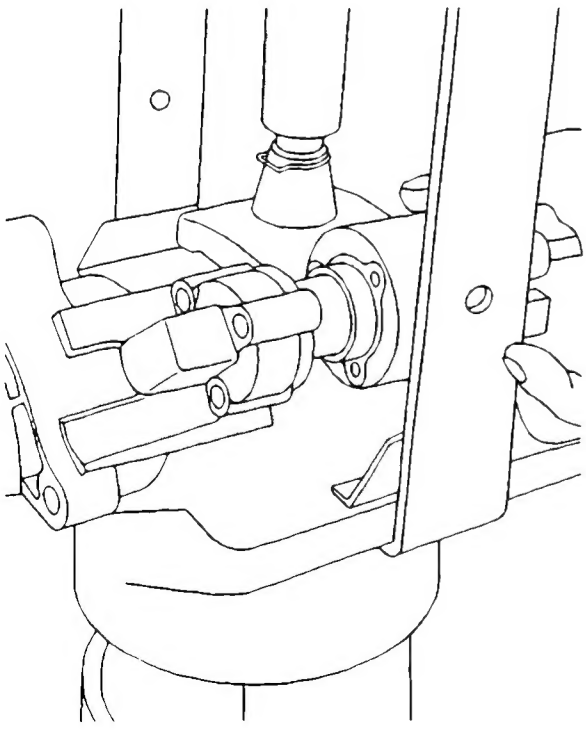
Assembling solenoid switch

Slip on solenoid switch and attach to drive-end bearing.
Pay attention to mark.
Use torque wrench.

Torx T25 bit socket:	comm. avail.
Torque wrench:	comm. avail.
Tightening torque:	4,5...6,0 Nm

Continue: V07/1 Fig.: V06/2

KMS00349



STARTING MOTOR ASSEMBLY

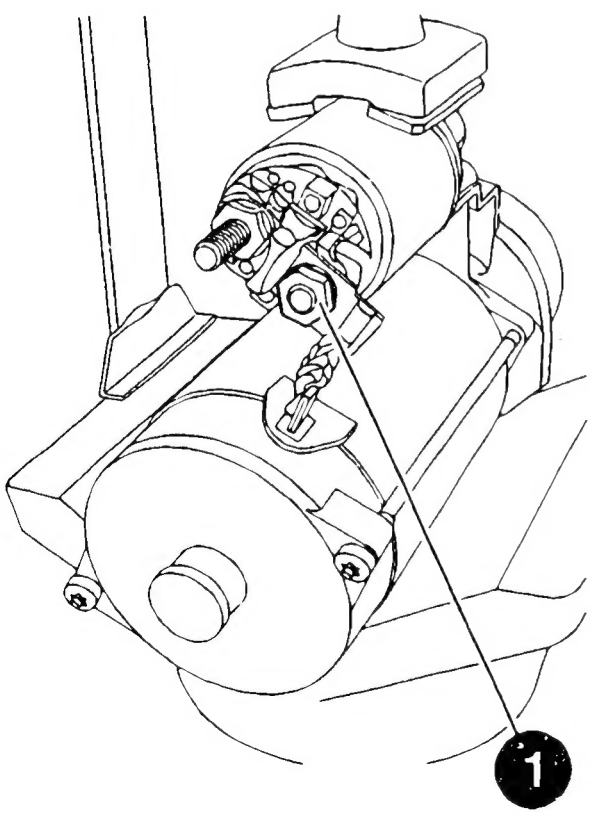
Assembling solenoid switch

Attach connection of brush holder (1) to solenoid switch.
Use torque wrench.

Tightening torque
term. 45: 10...12 Nm

Continue: IV10/2 Fig.: V07/2

KMS00494



STARTING MOTOR ASSEMBLY

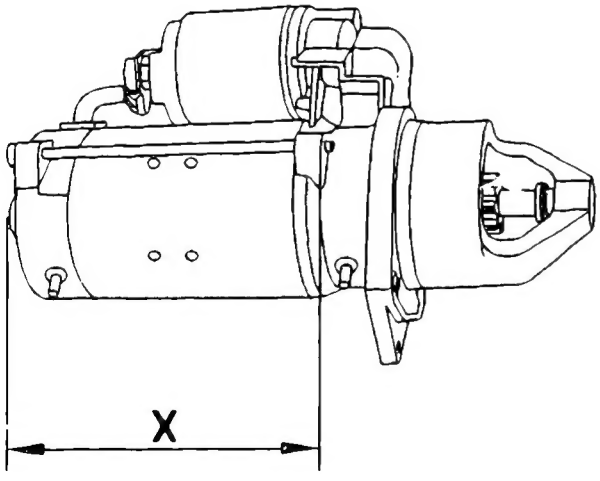
Sealing starting motor

Starting motor must be sealed following assembly.
This involves liberally applying nitrocellulose combination lacquer to starting motor in marked area (x) as shown.

Nitrocellulose combination lacquer
Ft 58 v 3: 5 899 607 017

Continue: IV10/2 Fig.: V08/2

KMS00346



EDITORIAL NOTE

Published by:
After-Sales Service Department for Training and
Technology (KH/VSK).
Time of going to press 08.1998.
Please direct questions and comments concerning the contents to our authorized representative in your country.

Continue: V09/2

EDITORIAL NOTE

Continue: I01/1